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Characterization of Two Agroforestry Systems in Southeastern Mexico

Final Report

CHARACTERIZATION OF TWO AGROFORESTRY SYSTEMS IN SOUTHEASTERN MEXICO

FINAL REPORT
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Prepared by

Lita C. Rule
Morris C. Rule
Joe P. Colletti
Patricia Negreros-Castillo

IOWA STATE UNIVERSITY
Department of Forestry
Iowa Agriculture & Home Economics
Experiment Station
Project No. 2986

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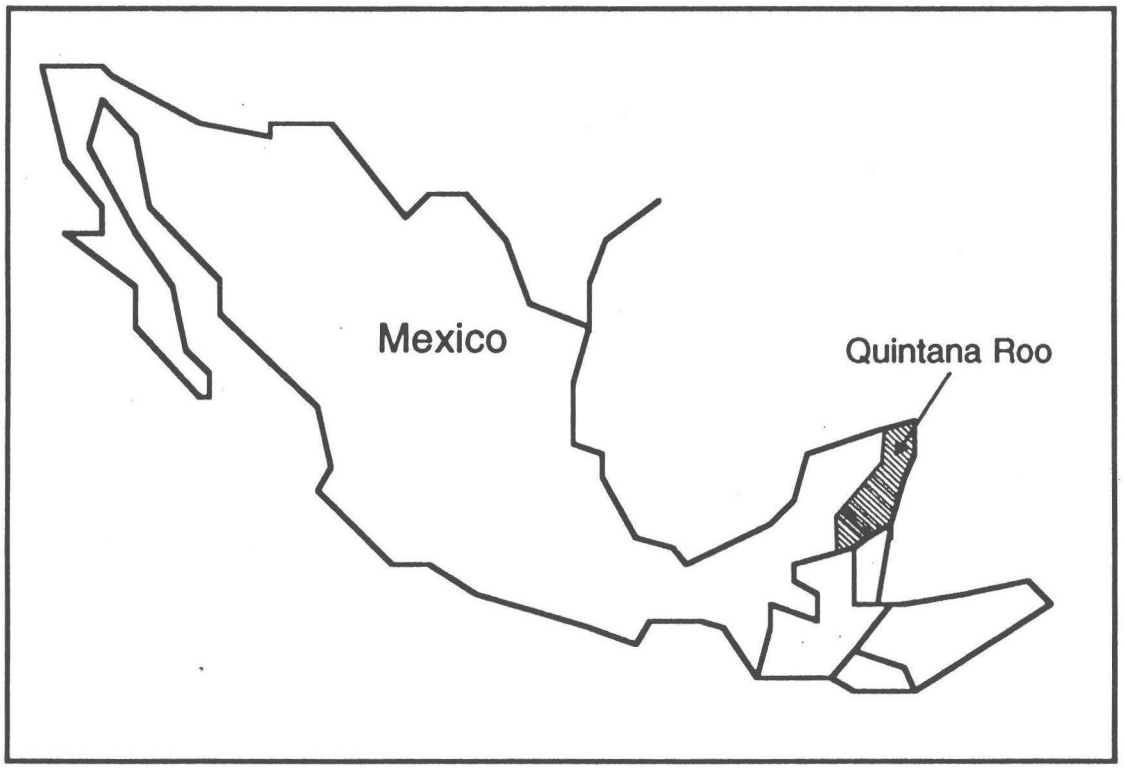

MEXICO

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EXECUTIVE SUMMARY
for

CHARACTERIZATION OF TWO AGROFORESTRY SYSTEMS IN SOUTHEASTERN MEXICO

Agroforestry is a land use option that has been increasingly accepted as environmentally sound and potentially sustainable. Land use systems are influenced by socio-economic and other developments, i.e., they change in response to various changes such as increased population and food demands, technological advances, urban developments, political or institutional changes, and other factors.

The management of sustainable land use systems is reinforced by strengthening the people's capacities, by developing effective linkages among supporting institutions involved, by developing appropriate technology packages, by devising participatory approaches to technology development and transfer, and by simply sharing and disseminating information about these systems. A primary step, however, is finding and analyzing information regarding these systems.

The survey on "Characterization of Agroforestry Systems" focused on two agroforestry systems that are practiced in Southeastern Mexico. The survey was implemented under the multi-year US/Mexico Agroforestry Development Project. Due to funding constraints, this project was shortened to one year. The general objective of the survey was to characterize and assess agroforestry systems and components managed by farmers in Southeastern Mexico. A companion survey, administered by the Mexican research partners, involved the evaluation of existing agroforestry development projects in the area. Initial efforts to forge plans for this particular collaborative activity with Mexican researchers began in November 1994 and then in February 1995. Subsequent planning activities for the survey drew on the results and discussions from these two meetings in developing the data collection instrument (survey) and the guiding research questions to be answered. Based on new developments and information given by the Mexican research partners, a June meeting was held whereby a set of specific

objectives was redefined, sampling procedures and system selection were finalized, and revamping of the original questionnaires was made. These caused a delay in the start of the survey activities as originally planned. The survey was conducted in the months of June and July in 1995 in two communities in the state of Quintana Roo in the southeastern portion of Mexico. These two areas were Zona Maya and Rio Hondo (also known as Zona Riberina).

For systems characterization, and based on the planning meetings mentioned above, two specific research objectives were redefined as follows:

1. To determine the management, productivity, and profitability of agroforestry systems, such as *solares* or *traspatio*, diversified plots with trees, *potreros acahuales* (pastures that are fallowed), and *milpa* with trees; and

2. To determine the justification and evolution of the systems in terms of their adoption, adaptation, benefits and utility, problems and future change plans for improvement, change, etc. from the point of view of the household.

In view of resource constraints, only two systems were chosen by the research team for this study, as described below.

METHODOLOGY

The study methodology was divided into several stages. They are as follows:

A. Selection of Systems for Characterization and Survey Sites

The survey focused on only two of the four agroforestry (or mixed tree-agronomic crop) systems that were identified as existing in Southeastern Mexico. The two systems considered were the *solares* or *traspatio* and the *parcelas diversificadas con arboles*. Excluded were the *acahuales en potreros,* and *milpas con arboles*. System selection was based on constraints relating to sites, existing systems, logistics, and available resources. Three criteria were applied in choosing these two systems: representativeness or

commonness of the system in the zone, high priority or interest for the farmers, and the system's potential to improve the conditions of the farmers.

The two communities where these two systems were located were Zona Maya and Rio Hondo. These are located in the Yucatan peninsula, particularly the state of Quintana Roo, in the southeastern part of Mexico (Figure 1: map of Quintana Roo). Zona Maya is located in the central part of the state. To the south and west of Zona Maya is the Rio Hondo community, located on the upper part of the Rio Hondo river. Rio Hondo was chosen over Calakmul, one of the two original study sites, because there were very few *parcelas* in Calakmul. Those *parcelas* that had existed had been abandoned and/or replaced by recently-adopted agroforestry projects introduced by the Calakmul Consejo.

B. Sampling Process/Interview Process

Sampling procedures at the field-level involved the following process. A list of those who have *solares* and *parcelas* was solicited from the *Comisireados* (i.e., the heads of the *ejido* councils). This list then served as the sampling frame of the survey team in the random selection of the respondents. Assistance was also requested from key people in the regional organization of the *ejidatarios* (i.e., the *Organización* in Zona Maya). The team also sought the help of the *Comisireados* for interpreters especially in Zona Maya where Spanish is not widely spoken. There were four interviewers for the survey, working in two-person teams.

Originally, a stratified random sampling was designed, involving two strata (*solar* and *parcela*, or the two systems). For each system, the minimum number of sample targeted was 30 respondents, 15 of which will come from Zona Maya and 15 from Rio Hondo. About 4-5 ejidos each in Zona Maya and Rio Hondo would be identified relative to this process, and also considering information regarding the practice of these two systems in these areas. There would be a minimum total of 60 respondents to be interviewed for this purpose.

However, the original sampling scheme was modified because of existing conditions found in both communities in relation to the

QUINTANA ROO

ESCALA 1: 600,000

0 5 10 15 20 25 Km.

1 CM. SOBRE EL PLANO REPRESENTA 6 KM. SOBRE EL TERRENO

SIMBOLOGIA

LIMITES

- Límite Internacional
- Límite Estatal
- Límite Municipal

VIAS DE COMUNICACION

CARRETERAS

- Dividida
- Principal
- Secundaria
- Revestida
- No. Carretera de Cuota
- No. Carretera Federal
- No. Carretera Estatal
- Kilometraje Total
- Kilometraje Parcial
- Puente de Cuota
- Aeropuerto
- Ferrocarril
- Transbordador
- Chalana

POBLACIONES

- Con más de 100,000 Hab.
- de 50,000 a 100,000 Hab.
- de 20,000 a 50,000 Hab.
- de 10,000 a 20,000 Hab.
- de 2,500 a 10,000 Hab.
- de menos de 2,500 Hab.
- Capitales de Estado
- Cabecera Municipal
- Elevación de Población sobre el nivel del mar
- Monte con elevación
- Volcán
- Río
- Lago
- Presa
- Pantano
- Parque Nacional
- Sitio Arqueológico
- Gasolinería

Tizimín
Valladolid
Tulum
Cobá
Felipe Carrillo Puerto
Chetumal
Parque de Quintana Roo
Zona de Lagunas y Cenotes
Isla Cozumel
Laguna Chichancanab
Laguna Esmeralda
Laguna Milagros
Laguna Chunyaxché
Laguna Xcalak
F.C. MERIDA-VALLADOLID
F.C. CAMPECHE-CHETUMAL
ESTADO DE YUCATAN
ESTADO DE QUINTANA ROO

MESETA
DE
ZOHLAGUNA
BELICE
GUATEMALA
Mar
Laguna Petenxil
Laguna Petexbatun
Laguna Salpetén
Laguna Yaxhá
Laguna Sacnab
Laguna Macanché
Laguna Ocom
Laguna Kucuy
Laguna Paixbán
Laguna Petivegua
Laguna Sac - Ayin
Laguna Sac - Kajal
Laguna Teresita
Laguna San Antonio
Laguna Virtud
Laguna Khuc Verde
Laguna Mariscal
Laguna Xcalal
Río Escondido
Río Azul
Río Hondo
Flores
Melchor de Mencos
Poptún
Dolores
Sayaxché
Tikal
Uaxactún
Felipe Carrillo Puerto
Chetumal
Bacalar
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Isla Arena
Isla Aguada
Isla Cayo Arcas
Isla Cayo Nuevo
Isla Cayo Triángulos
Isla Cayo Obispo
Isla Cayo Norman
Isla Cayo Centro
Isla Cayo Lobos
Isla Cayo Culebra
Isla Cayo Cormorán
Isla Cayo Pelícano
Isla Cayo Mujeres
Isla Cayo Arenas
Isla Cayo Alacranes
Isla Cayo Pérez
Isla Cayo Chiquero
Isla Cayo Desterrado
Isla Cayo Blanco
Isla Cayo Piedras
Isla Cayo Sombrero
Isla Cayo Cochinos
Isla Cayo Palmas
Isla Cayo Palmitas
Isla Cayo Palmitos
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Isla Cayo Palmitos

distribution and practice of *solares* and *parcelas*. Except for the minimum target of respondents, selection of the sample was modified, as described below.

Total enumeration, rather than random selection, of respondents for the *parcelas* had to be undertaken. Meetings with the *Comisireados* as well as the *ejidatarios* yielded the information that *parcelas diversifacadas* were not as common as expected. Based on the suggestions of the *Comisireados* or *ejidatarios,* the process followed was to go by the names of those who were identified as operating this particular system.

Likewise, random sampling of respondents for the *solares* in Zona Maya was not possible. This was because the selected respondents frequently did not speak Spanish. Interpreters were not readily available. Consequently, the ability to speak Spanish by a member of a household became a criterion in the choice of respondents for the *solares*.

The agroforestry questionnaire was pre-tested before it was implemented in the field.

There was a total of 64 respondents interviewed representing 33 *solares* (18 in Zona Maya and 15 in Rio Hondo) and 31 *parcelas* (16 in Zona Maya and 15 in Rio Hondo). Please see Appendices 1 to 5 for the survey instrument used, editing field guidelines, soil types in Quintana Roo, list of tree species, and an economic analysis of example tree-crop systems using a discounted cash flow model.

C. Data Analysis

Using a PC-based statistical program, the data were tested for such things as variations between groups, data correlation, and possible trends. All analysis were based on actual figures reported by respondents. Significant findings were identified and organized in regards to the original objectives of the study and presented here in this report. A very brief reiteration of some of the key findings follow. All dollar figures were in nominal 1995 dollars.

Although it would have been interesting to know also whether or not there are differences in the system practices between the two

communities (Zona Maya and Rio Hondo), this report will focus only on the characterization of the parcela and the solar, including a comparison of these two systems.

KEY FINDINGS

There are two groups (solar and parcela) of respondents in this survey. Results showed that almost all of the parcela respondents are male (97%) while an almost equal representation of male and female respondents characterizes the solar group. This could be explained by the fact that most farm activities in the parcela are male-dominated activities. Most of the respondents in the two groups fall between 30 and 65 years of age. The average age for the solar group is 41 while for the parcela group is 55. Education-wise, the two groups do not differ much - average education for parcela respondents is Grade 3 while for the solares, it is Grade 4. In terms of family size, the two groups showed to have large families: parcela respondents have an average of seven children while the solares group has an average of five kids.

The question as to whether or not their areas were parceled elicited only10 responses, 9 of whom said that their areas are non parceled. This finding is found to be consistent with the common land arrangement in the Yucatan peninsula, which is collective ownership. Non-parceled areas mean these areas are usually under collective ownership by the ejido.

Over half of all respondents surveyed (52% for parcela and 55% for the solar) are not native to the ejido they presently are residing in. More than a third come from Yucatan while the rest come from various regions (14 regions in all). Majority of the respondents came to their present ejido during the 1971-1985 period. However, most parcela respondents have been in their present location longer than the solar respondents. The major reason cited by both groups for transferring to their present ejido is to improve their socio-economic welfare.

Two thirds of parcela respondents have their own solar before starting their own parcela in their present ejido. This finding is not

surprising because in the Yucatan, solares or home gardens are very common agricultural systems.

When it comes to involvement with organized groups, respondents in both groups reported membership mostly to producers' organizations. Examples of these producers' groups are the sugarcane planters, wood producers, the procampo, honey producers or apiculturists, and chicle producer groups. Some also reported membership in ejido committees and women's' group. The major source of family income is farming which was cited by most of the respondents from the two groups. The same source is also cited by the spouses when asked the same question. When asked about other sources of income, farming is, again, the most commonly cited source. There were several other income sources cited but these were mentioned only by one or two individuals.

When queried as to why they chose their present farm site, both groups mostly mentioned better soil and accessibility. The topography of the sites in both systems are described to be mostly flat or plain and rolling or undulating. The soils are mostly of the tesk'el, k'ankab, or puus lu'um. Description of these soil types are presented in Appendix 3. Most of the respondents reported to have a water system: 97% for solar group and 68% for parcela group. But while 94% of the solar respondents mentioned faucet (potable) as their water source, parcela respondents have varied sources. These include deep well, well with pump, or stream/brook/lake. This situation could perhaps be attributed to the distance of the parcela from the respondents' homes which is 3 kilometers in the average, or a walking distance of 30 minutes. Thus, building an elaborate faucet system in the parcela would mean a very expensive enterprise which many of them, if not all, could not afford.

The reasons for developing the agroforestry systems are not so very different between the two groups. Parcela respondents mostly mentioned the work opportunities provided and that the parcels were just given to them by relatives. With these reasons, many of the solar respondents added residence as being located near the area and also for subsistence. Both groups also mentioned their own experience or family tradition as their basis for the developments/ changes in their system of farming. This may be explained by the

fact that most of the respondents have a farming background and were exposed to agricultural activities at an early age.

In terms of the trees planted upon establishment, there were more species mentioned by the parcela group than by solar respondents. But the most common tree species planted in both systems are similar and included sweet orange, coconuts, avocado, limon, mango and mamey. For the non-tree crops, the most common species reported by the two groups again are similar and include corn, squash, frijol, pepper, and banana. The animals brought in to the systems were mostly chicken, pigs, and sheep. When asked about the sources of these species, both groups mostly mentioned that they either own the planting stock, or purchased them, or that they come from other ejidatarios (more solar respondents reported this source), from another plot, or from agroforestry technicians.

Changes were also made in both parcela and solar sites. Most of these were crop diversification (for trees and non-tree crops) and animal diversification in case of animals. Most of these changes were undertaken from 1991 to 1995 period. The reasons mentioned for these changes were: for tree components -- for posterity or for future generation, for better production, and for opportunity to plant more fruit trees; for non-tree crop component -- better production, in case of parcela and for consumption, in case of solar group. With regards to animals, the same main reasons were forwarded. Where do they get the ideas for these changes? Both groups mentioned personal experience or knowledge. And for the resources of these changes, both groups mentioned themselves as the primary source.

The areas presently under cultivation vary a lot in the two systems. For the parcela, the average size is 5.56 hectares while for the solar, the average is 0.36 hectares. The range was much wider for the parcela (0.32 ha. to 40 has.) than the solar (0.02 ha. to 2 has).

Many of the respondents use material inputs in their farms. Most of these are in the form of fertilizers, weedicides and pesticides for trees and non-tree crops; and vaccines and deparasitation, for the animals. The more frequently mentioned inputs are Triple 17 and urea for fertilizers, and a variety of weedicides, pesticides, and animal sanitation inputs. The costs of these inputs also vary a lot.

More costs are incurred by parcela respondents for tree and non-tree crop components, while solar respondents spend more on animal care. For both systems, many of these inputs were either produced locally or purchased from nearby towns. Few also mentioned the government and the *ingenio* (sugar refineries) as their sources.

When it comes to labor inputs, almost all members of the family, including the respondent, were involved in almost all farm activities that concern the managing of the three system components. One interesting finding is that the animal feeding activity (mostly cutting of forage/pasture) was done by the wife. This was reported by 16 solar respondents but none from the parcela group.

Concerning hired labor, the results showed that more of this resource is reported by the parcela group for all three components. Most of this hired labor was for weeding, harvesting, fertilization, pruning, and vaccination. Hired labor is always paid in cash.

For overall operations of the agroforestry system (i.e. production, processing, and marketing), it was mentioned by both groups that almost all decisions were made by the farmer himself/ herself. In some instances, however, he/she is helped by the spouse, children, parents, and siblings. Almost the same trend was observed when respondents were asked who decides on how work responsibility should be divided. As to deciding whether or not to hire labor, the result was not so significant as only few answered this question (9 from parcela and only 3 from solar).

The production patterns of the two systems were not very different from each other. Both groups mostly mentioned fruits as the primary products they get from trees which include oranges, mango, coconuts, avocado, limon, and mandarin. For the non-tree crops, bananas is the most common. However, more and varied products were reported by the parcela respondents. The same is true with the products they get from the animals. For the market outlets, the most common is the local market (direct marketing).

The ejidatarios also expressed potential problems with their systems. For trees, both groups reported to foresee the following: plant or animal pests and disease, lack of irrigation system/water

resources, low prices, and lack of market facilities. The last three problems, however, are reported more by parcela than by solar respondents. Regarding the problems foreseen for the livestock and non-tree crop components, more problems were mentioned by the parcela group. Most common of these are plant or animal pests/ diseases and lack of water system. Examples of these pests are ants, mosquitoes, and birds that eat the fruits.

Regarding future plans, both groups of respondents expressed a mixture of contrasting activities or ideas. For the parcela, plans range from adding/growing additional or more crops, trees, and animals to keeping the land as it is (i.e. no changes are planned) to quit raising livestock. On the other hand, one-third of solar respondents planned to remove some trees and another one-third wants to add/grow additional trees. Few of them also mentioned that they want their solares as they are now.

When asked about their views and perceptions regarding new changes in land tenure, responses from both groups vary. Parcela respondents commonly mentioned that they do not know or do not understand these laws, in the first hand. Similarly, many from the solar group expressed their lack of understanding about these laws. No matter how they view these changes in laws, many of them believed that these changes will not affect their plans for their systems.

CHARACTERIZATION OF TWO AGROFORESTRY SYSTEMS IN SOUTHEASTERN MEXICO

FINAL REPORT

I. INTRODUCTION

In many areas of the world, agroforestry is a wedlock for survival. It is a system of producing diverse agronomic and forestry (hence "agro-forestry") outputs, a feature that may be very practical in trying to strengthen and diversify economies that are primarily agricultural. For about 10,000 years, farmers have relied on their own resources and knowledge and have demonstrated keen understanding of the principles of sustainability by having sustained agricultural systems (some of which are what is now called agro-forestry) in China, Mexico, Indonesia, Nepal, Philippines, Peru, and other parts of the world (Gonsalvez, 1991). In the United States, the notion of greater production through mixing forestry and agricultural practices was advocated as early as 1914 (Smith 1914). However, agroforestry ideas seem to have been emphasized earlier in the tropics than in temperate regions. Today, these practices can be found around the globe, addressing problems related to food, environment, energy, and resource conservation, as well as problems in areas where increasing populations call for greater production from a fixed land base.

Agroforestry attempts to link agriculture with the longer-term protective, productive, and social functions of trees and other woody and herbaceous vegetation. In agroforestry, economically beneficial perennials like fruit trees, fuel wood, and leguminous vegetation are incorporated in a farm to produce food, fuelwood, fodder, and fiber; to perform functions like soil improvement, erosion control, wind breaks, and as nurse crops to other plants on the farm; to provide shade to animals and serve as living fences; and as a source of cash revenue. Thus, agroforestry can be adapted to suit the individual needs of farmers and the climatic conditions and problems of an area. The system has a strong potential for improving agricultural productivity, profitability, sustainability, and biodiversity in areas

where resource degradation, deforestation, and/or poverty are primary concerns. In particular, agroforestry has potential for improving the socio-economic welfare of peasant farmers.

In Mexico, agroforestry has been promoted by the government through support given to tree planting in the country. For instance, the Mexican Forest Service, or SARH, has planted 170 million trees in 1994 alone. In the United States, agroforestry is still a young discipline and has only come into practice perhaps in the last two to three decades. In the United States, the development of agroforestry has also been encouraged mostly using alley cropping practices and also through forestry-related systems, such as shelter belts, wind breaks, and riparian buffer strips, in order to conserve soil and water, to increase biodiversity, and to respond to environmentally-related issues, such as non-point source (NPS) pollution. Within the context of the agricultural economies of Mexico and the American Midwest, and borrowing from the definition given by the USDA National Agroforestry Center, agroforestry may be described as the strategic placement of the right trees in the right places in the landscape for their protective, productive, and social functions.

Agroforestry is one land use option that has been increasingly identified as environmentally sound and potentially sustainable. Land use systems are always under the influence of socio-economic and other developments and they change in response to various changes such as increased population and food demands, technological advances, urban developments, and institutional or political changes, and other dimensions. Thus, the management of sustainable land use systems will also be sustained through strengthening of the people's capacities, by developing effective linkages among the institutions involved, by developing appropriate technology packages, by devising participatory approaches to technology development and transfer, and by simply sharing and disseminating information about these systems. The primary step, however, is finding and analyzing information regarding these agroforestry systems.

II. BACKGROUND OF THE STUDY

The survey on "Characterization of Agroforestry Systems" is one of two major field-level research activities in Southeastern Mexico that have been planned for the multi-year US/Mexico Agroforestry Development Project. Due to funding constraints, this project was shortened to one year. Specifically, the survey addressed the objective of characterizing and assessing agroforestry systems and components managed by farmers and existing agroforestry development projects. Initial efforts to forge plans for this collaborative activity with Mexican research partners began in November 1994 and then in February 1995. Subsequent planning activities for the survey drew on the results and discussions from these two meetings in developing the data collection instrument (survey) and the guiding research questions to be answered. Based on new developments and information given by the Mexican research partners, a June meeting was held whereby a set of specific objectives was redefined, sampling procedures and system selection were finalized, and revamping of the original questionnaires was made. These caused a delay in the start of the survey activities originally planned. The survey was conducted in the months of June and July in1995 in two communities in the state of Quintana Roo in the southeastern portion of Mexico. These two areas were Zona Maya and Rio Hondo (also known as Zona Riberina). The agroforestry questionnaire was pre-tested before it was implemented in the field.

III. METHODOLOGIES

Selection of Systems Surveyed

Four agroforestry (mixed tree-crop) systems in the Yucatan were initially identified and considered for the survey on systems characterization. These systems were: (1) *solares* or *traspatio*, (2) *parcelas diversificadas con arboles*, (3) *acahuales en potreros*, and (4) *milpas con arboles*. The *solares* or home gardens are areas near or around residences where various trees are planted for food or fodder, and where animals (fowl, livestock) are also usually raised. The *parcelas diversificadas*, also known as *ranchitos*, are diversified farm plots where agronomic crops are planted with trees, shrubs and/or forage. The acahuales *en potreros* are degraded pastures

that are left to fallow, while *milpas con arboles* refer to areas where the *rosa-tumba-quema* or burn-fell cultivation is practiced and where trees are purposely left to grow.

The survey focused only on two of the four systems mentioned above -- the *solares* or *traspatio* and the *parcelas diversificadas con arboles* . This decision was based on new information presented by the Mexican research partners on the sites and the possible number of the existing systems therein, the logistics, and the tremendous time and resource requirements to do a survey of all systems. The following criteria were applied to select only two systems to be included in the survey for characterization purposes:

1. the representativeness or commonness of the system in the zone;

2. the high priority or interest for the farmers; and

3. their potential in terms of improving the conditions of the farmers.

The two communities where these two systems were located were Rio Hondo and Zona Maya. Rio Hondo was chosen over Calakmul, one of the two original study sites, because there were very few *parcelas* in Calakmul. Those *parcelas* that had existed had been abandoned and/or replaced by recently-adopted agroforestry projects introduced by the Calakmul Consejo.

Sampling Procedures

Sampling procedures at the field-level involved the following process. A list of those who have *solares* and *parcelas* was solicited from the *Comisireados* (i.e., the heads of the *ejido* councils). This list then served as the sampling frame of the team in the random selection of the respondents. Assistance was also requested from key people in the regional organization of the *ejidatarios* (i.e., the *Organización* in Zona Maya). The team also sought the help of the *Comisireados* for interpreters especially in Zona Maya where Spanish is not widely spoken.

The original sampling scheme was slightly modified, based on existing conditions found in both communities in relation to the

distribution and practice of *solares* and *parcelas*. Originally, for instance, 4-5 *ejidos* were to be selected from each of Zona Maya and Rio Hondo. The choice of *ejidos* was to consider their geographic location relative to the distribution of the systems as known by the Mexican research partners. For Zona Maya, a minimum total of 30 respondents was to be selected randomly from the chosen ejidos, with 15 samples representing the *solares* and 15 for the *parcelas*. The same will be done for Rio Hondo.

Except for the minimum target of respondents, selection of the sample was modified, as described below.

Rather than random selection, total enumeration of respondents for the *parcelas* had to be undertaken by the survey team. Talks with the *Comisireados* as well as the *ejidatarios* yielded the information that *parcelas diversifacadas* were not as common as expected. Based on the suggestions of the *Comisireados* or *ejidatarios*, the process followed was to go by the names of those who were operating this particular system.

Likewise, random sampling of respondents for the *solares* in Zona Maya was not possible. This was because the selected respondents frequently did not speak Spanish. Except in one instance when the team requested the help of two high school students, interpreters were not available since those who were expected to help in this regard had prior commitments. Consequently, ability to speak Spanish by a member of a household became a criterion in the choice of respondents for the *solares*.

There was a total of 64 respondents interviewed representing 33 solares (18 in Zona Maya and 15 in Rio Hondo) and 31 parcelas (16 in Zona Maya and 15 in Rio Hondo).

Responses were analyzed using a PC-based SPSS (Statistical Program for Social Sciences) package. Based on the two systems -- parcelas diversificadas and solares -- descriptive statistics were computed such as averages or means and frequencies. Cross tabulations were determined for appropriate responses to see the condition that applies to each of these systems with respect to selected variables. All analyses were based on what respondents

have in their system, inputs, outputs, other socio-economic-demographic characteristics, and other variables.

For selected variables, t-tests and chi-square tests were conducted to test for significant differences in the means of the two systems at the 0.05 level of significance.

It is important to remember that the results and findings of this study are based on the data from the participating farmers and have not been translated to represent the entire population of agroforestry practitioners in the Yucatan.

IV. ORGANIZATION OF RESULTS

The results of the survey are presented in specific sections that relate to the objectives. This survey focused on two of the four agroforestry systems that are practiced in southeastern Mexico: the *solares* or *transpatio* and the *parcelas diversificadas con arboles* or simply *parcelas*. These two systems were chosen based on: (1) representativeness or commonness of the system in the zone; (2) high priority or interest for the farmers; and (3) the system's potential to improve the conditions of the farmers. The regions or sites covered in the survey are Zona Maya and Rio Hondo.

The presentation starts with the background of the study where the sites or regions and the agroforestry systems practiced are discussed. This is followed by the section on the methodologies which touches on how the two agroforestry systems were selected and how the sampling procedures were undertaken.

A separate section on Quintana Roo is included. This is the state where the two study sites are located, and where all pertinent information about the two regions were further discussed. This is followed by the section that gives information about the respondents. These include information on the original ejido or place of origin prior to coming over to the new place, reasons for this transfer, socio-economic-demographic information, and organizational memberships.

The next three sections pertain to several characteristics of the two systems. First of these is the section that describes the charac-

teristics of the *solares* and the *parcelas* based on the three components -- trees, non-tree crops, and animals. It includes the description of the two systems' biophysical characteristics, and their characteristics during the establishment, intermediate, and present phases. A discussion on how the systems are operated and managed follows next. This section deals with the kinds/types of inputs (material and labor) that were used and the aspects regarding farm management and decision making process. The main areas where decision making is crucial include the overall agroforestry operations (i.e. production, processing, and marketing), distribution of work responsibility, and whether to hire farm labor or not.

Information on the agroforestry system production patterns is presented next where the following are discussed: products harvested from the three components, quantities harvested and quantities sold, and the uses of the products that were not sold. This is followed by a discussion on the problems foreseen by the ejidatarios, their future plans regarding their agroforestry systems, and their views and perceptions regarding the changes in land tenure laws concerning their ejido.

A summary of the study is then presented.

A very important additional information in this report is an economic analysis of three parcela models that involve mahogany (caoba). Presented in Appendix 5 are three discount cash flow models that have been analyzed using three economic criteria: net present value, annual equivalent value, and internal rate of return. This information is presented in order to show the potential profitability of such systems in the Yucatan. Although the detailed data for these models were obtained in 1994, the models themselves are developed specifically for the area and involve combinations of caoba with shorter duration crops such as corn (maize) and oranges (naranja). Caoba and these crops are very common in southeastern Mexico. These models are intended to show profitability of tree-crop (agroforestry) systems in this part of the country.

V. STUDY AREA: QUINTANA ROO

The state of Quintana Roo is located along the eastern portion of the Yucatan peninsula between $21^{0}39'$ north, $17^{0}49'$ south, $86^{0}42'$ east, and $89^{0}24'56"$ west. The peninsula projects northward into the gulf of Mexico as a great limestone platform joined at its base to the Sierras of northern Central America. Quintana Roo is bordered by two countries, Guatemala to the south and Belize to the southeast. It comprises an area of 50,843 km^2, with 865 kms of coast line along the Caribbean Ocean. The population in 1993 was 642,770 inhabitants. More than 74% of the population is concentrated in 18 towns, and 26% is dispersed in about 1,285 communities (Tables 1 to 3). Two thirds of the population lives closer to the coast. The economically active population in 1990 was 323, 021 (out of 642,770 inhabitants), 154,600 of whom are women and 168,421 are men.

Table 1. Population distribution by size of town, (1990 figures)

Town size (Number of inhabitants)	Number of towns
1-99	1,052
100-499	154
500-999	53
1,000-1,999	20
2,000-2, 499	6
2,500-4,999	11
5,000- 9,999	3
10,000-14,999	1
20,000-49,999	1
50,000-99,999	1
100,000-499,999	1

Source: INEGI, 1994

Quintana Roo's major economic activity is tourism which accounts for 30% of the country's gross income (Table 4). Sixty percent (60%) of the active population is in this sector. This is followed by fishing and agricultural activities engaged in by 20% of active population. In 1993, a total of 70,148 hectares were grown to agricultural crops, of which 21,181 hectares are grown to fruit trees.

The industrial sector, on the other hand, employs 15% of the active population. And as can be gleaned from Table 4, only 5% of the total population do not have clear economic activities.

Table 2. Quintana Roo's population indicators.

Indicator	Quintana Roo %	Mexico %
% Population	2.5	100
Population growth 1980-1990	6.9	1.95
Households without drinking water	18.7	22.7
Households without electricity	16	12.5
Household with soil floors	27	19.5
Indigenous pupulation	33	7.2
Illiterate population	15	12
Average years of school	5	6

Source: Villanueva, 1993; INEGI, 1994

Table 3. Quintana Roo's economic indicators.

Indicator	Quintana Roo %	Mexico %
Agriculture	2.5	100
Population growth 1980-1990	6.9	1.95
Households without drinking water	18.7	22.7
Households without electricity	16	12.5
Household with soil floors	27	19.5
Indigenous pupulation	33	7.2
Illiterate population	15	12
Average years of school	5	6

Source: Villanueva, 1993; INEGI, 1994

The Mayan heritage of the region is very present nowadays with 651 Maya communities located in the heart of the state where people do most of their agricultural and forestry activities. The area for profitable agricultural activities is, however, very small and is concentrated only in the southern border with Belize along the Hondo river (Villanueva, 1993). On the southern part of the state, the major activities are commerce together with administration.

Originally, the state was approximately 90% forested but now the forest has been reduced to about 30%. The soils are predominantly rendolls (USA Soil Taxonomy) or rendzinas (USA old classification) (Brady, 1984). There are no surface streams because

water moves freely into the underlying limestone, forming sinkholes (Stringfield and LeGrand, 1974). The climate is described as warm submoist with dry summers. Annual precipitation is between 1000 and 1200 mm and is unevenly distributed. The dry period is from 3 to 4 months usually from August to April. The mean annual temperature is 26°C with a minimum of 8°C (Tamayo, 1981). Holdridge (1947) classified the vegetation of this region as tropical dry forest formation while Pennington and Sarukhán (1968) called it as *selvas subperennifolias*. Rzedowski and Rzedowski (1989) classified them as tropical semi-evergreen forest.

Table 4. Quintana Roo's economic activities, by percentage of active economic population (1993 figures)

Economic activity	Population %	Value US$
Fishing and agriculture	20	**150,474**
Agricultural Crops		33,566
Cattle		97,735
Forest products		5,773
Fishing		13,400
Industry	15	**18,640**
All types		18,640
Comerce and services	60	**545,139**
Comerce		94,000
Tourism		451,139
Other	5	--

Source: INEGI, 1994

The composition of the forest is the result of the precipitation regime and soil types as well as hurricanes, fires, and mostly agricultural activities since pre-colonial times (Snook, 1993; Barrerra and Gómez-Pompa, 1977; Edwards, 1986). The most abundant tall tree species are ramon (Brosimum alicastrum) and chico zapote or zapote (Manilkara zapota) while the most commercially valuable species are mahogany and Spanish cedar.

Several governmental programs exist to support agricultural activities in the region. Some of the important ones are the regional program to develop the Maya zone, an agricultural program called "procampo", a forestry program "Solidaridad Forestal", a cattle and honey production program, and the small forest industry program.

VI. BACKGROUND INFORMATION ON RESPONDENTS

A. Distribution of Respondents

This section discusses the distribution of the respondents according to their present region and ejido, how long they have been in these places, where they come from if they are not natives of the locality, their reasons for moving to Zona Maya or Rio Hondo, and other aspects relating to their farming systems.

There were 64 respondents in all, with 33 respondents for solar and 31 for parcela. Of this total, 34 were from the Zona Maya region and 30 from Rio Hondo. There were 18 solar and 16 parcela respondents for Zona Maya, coming from six different ejidos. For Rio Hondo, there were 15 respondents for each system coming from nine ejidos. The distribution between the two systems for each community is given on Table 5. The respondents were asked whether or not their solar or parcela was parceled (subdivided within the ejido). Nine of the 10 who responded to this question said that their areas were non-parceled. Non-parceled areas mean that these are under collective ownership by the ejido. Further, the children will inherit the right to farm an area within the ejido but not necessarily the one that is cultivated by the parents. In the Yucatan Peninsula, collective ownership is the more common arrangement.

Over half of the parcela (52%) and solar (55%) respndents were not native to the ejido they are presently residing in. These numbers were not significantly different as indicated by a chi-square test at the 0.05 level (Table 6). The respondents came from 15 regions and a total of 27 different ejidos in Mexico (Table 7). More than one third (39%) were from Yucatan. They came to the present area starting in 1925 and as late as 1985 (Table 8). The majority (78%) came during 1971-1985. Parcela respondents have been in their present location longer (average of 40 years) than solar respondents (30-year average) (Table 9). Chi-square tests indicated a significant difference in these time periods at 0.05 levels. However, it must be pointed out that solares or home gardens are very common in the Yucatan. On the other hand, parcela is less common and some people may have a "milpa" instead of a parcela, and yet they may also have a solar in addition to this. In fact, for parcela respondents, 22 people (73%) have reported that they did have their own solar before they started their parcelas.

Table 5. Respondents' present region and ejido.

Ejido	Solar		Parcela		Total	
	No.	%*	No.	%	No.	%*
Zona Maya						
X-Maben	5	15	4	13	9	14
Laguna Kana	3	9	5	16	8	13
X-Pichil	5	15	2	7	7	11
Cafetal Limones	2	6	4	13	6	9
Betania	3	9	-	-	3	5
Carillo Puerto	-	-	1	3	1	2
Sub-total	**18**	**54**	**16**	**52**	**34**	**54**
Rio Hondo						
Juan Sarabia	6	18	5	16	11	17
Allende	2	6	2	7	4	6
Alvaro Obregon	1	3	2	7	3	5
Cacao	2	6	1	3	3	5
Puc-te	2	6	1	3	3	5
Palmar	1	3	1	3	2	3
Calderon	-	-	1	3	1	2
Roviroza	1	3	1	3	2	3
Sabidos	-	-	1	3	1	2
Sub-total	**15**	**45**	**15**	**48**	**30**	**48**
Grand Total	**33**	**99**	**31**	**100**	**64**	**102**

* Percentage column may not equal to 100% because of rounding off errors.

Table 6. Whether or not native to the locality.

Response	Solar		Parcela		Total		X_i^2-test
	No.	%	No.	%	No.	%	
Yes	14	42	15	48	29	45	ns
No	18	55	16	52	34	53	-
Missing	1	3	-	-	1	2	-
Total	33	100	31	100	64	100	

ns No significant difference in values at 0.05 level.

Table 7. Respondents' original region and ejido*

Region and ejido	Solar		Parcela		Total	
	No.	%	No.	%**	No.	%**
Yucatan	**6**	**38**	**7**	**41**	**13**	**39**
Valladolid	4	25	1	6	5	15
Motul	1	6	1	6	2	6
Sotuta	1	6	1	6	2	6
Tekax	-	-	2	12	2	6
Dzam	-	-	1	6	1	3
Dechax	-	-	1	6	1	3
Veracruz	**2**	**13**	**2**	**12**	**4**	**12**
Alamo	-	-	1	6	1	3
Papautla	-	-	1	6	1	3
Patrillo	1	6	-	-	1	3
Toxpan	1	6	-	-	1	3
Machoasen	**3**	**19**	**-**	**-**	**3**	**9**
Jenpa	1	6	-	-	1	3
Monda	1	6	-	-	1	3
Zamora	1	6	-	-	1	3
Quintana Roo	**1**	**6**	**1**	**6**	**2**	**6**
Botes	-	-	1	6	1	3
Chunguas	1	6	-	-	1	3
Zamora	**2**	**13**	**-**	**-**	**2**	**6**
Zamora	1	6	-	-	1	3
Michoacan	1	6	-	-	1	3
Oaxaca						
Huaguapon deLeon	1	6	-	-	1	3
Tabacco						
Santa Cruz	1	6	-	-	1	3
Yaotepec						
Morelos	1	6	-	-	1	3
Zaceteces						
Zaceteces	1	6	-	-	1	3
Chamacon						
Guerrero	1	6	-	-	1	3
Campeche						
Champoton	-	-	1	6	1	3
San Bertele						
Hidalgo	-	-	1	6	1	3
Tacotalpa						
Tabasco	-	-	1	6	1	3
Tlapaeoga						
Veracruz	-	-	1	6	1	3
Viejo						
Chunguas	-	-	1	6	1	3
Total	16	100	17	101	33	99

* Based only on those who reported moving to their present ejido. Bold figures are sub-total for each region having more than one ejido.

** Percentage column may not equal to 100% because of rounding off errors.

Table 8. Year when respondents move to present ejido.

Year	Solar		Parcela		Total		X_i^2-test
	No.	%	No.	%	No.	%	
1925-1940	1	3	1	3	2	3	
1941-1955	2	6	3	10	5	8	
1956-1970	3	9	4	13	7	11	
1971-1985	27	82	23	74	50	78	
Total	33	100	31	100	64	100	ns

ns No significant differences between values at 0.05 level.

Table 9. Number of years spent in present ejido.

	Solar	Parcela	Total	X_i^2-test
N	33	31	64	
Average	30	40	35	*

* Significant differences in means at 0.05 level.

The reasons given for the transfer to their current ejido generally indicated a search for improvement in the socio-economic welfare of respondents (Table 10). Thirty-four individuals (18 for solar and 16 for parcela) provided information on these reasons that were then classified into four major groups as follows: opportunities in the present place (47%), land access (32%), relatives or family (9%), and work/residence (12%). When further condensed, land-related opportunities such as production of desired species, better land productivity, and access to land, would constitute the biggest rationale for the move to the new ejido (83% for solar and 75% for parcela respondents). The government has less to do with people from both groups transferring from one ejido to another. Of the 34 respondents reporting, six people (or 17%) indicated that their move was assisted by the government, while the rest (83%) indicated otherwise (Table 11).

Table 10. Reasons for moving to present ejido.*

Reasons	Solar		Parcela		Total	
	No.	%	No.	%	No.	%
Opportunity in present locality	9	50	7	44	16	47
Land access in present place	6	33	5	31	11	32
Because of relative and/or family	2	11	1	6	3	9
Work	1	6	2	13	3	9
Residence	-	-	1	6	1	3
Total	18	100	16	100	34	100

* Reported only by those who moved to the present ejido.

Table 11. Whether or not this moving in is a government-supported program.*

Response	Solar		Parcela		Total		X_i^2-test
	No.	%	No.	%	No.	%	
Yes	5	28	1	6	6	18	
No	13	72	15	94	28	82	
Total	18	100	16	100	34	100	ns

* Provided by those who moved to the present ejido.
ns No significant difference at 0.05 level.

Most of the respondents have some kind of farming background at an early age (Table 12). For instance, most of the respondents (58 people, or about 91%) were already involved in farming activities, but not their own farm yet, at an average age of 12 years (average was 12 years for parcela and 13 years for solar respondents). Some of them started when they were as young as 5 years old. They would start operating their own farms at the average age of 22 years, with an age range from 8 years to 70 years (Table 13). In both cases, chi-square test indicated no significant differences between the two groups of respondents. These imply that farming background as well as their ages when first involved with farming activities are more or less the same for both groups.

Table 12. Average age when respondents started helping in another person's farm.

Age	Solar	Parcela	Total	t-test
N	28	30	58	
Average age	13.3	11.9	12.6	ns
Range	5-45	5-22	5-45	

ns No significant difference in means at 0.05 level.

Table 13. Average age when respondents started operating own farm.

Age	Solar	Parcela	Total	t-test
N	32	29	61	
Average Age	21.4	22.3	21.9	ns
Range	8-45	10-70	8-70	

ns No significant difference in means at 0.05 level.

Changes were also reported regarding past and present practices or situations (Table 14). For instance, 52% of the parcela respondents reported differences relating to soil quality and/or productivity, livestock, accessibility, more trees or plants, profit, and water. For 33% of the solar respondents who indicated differences in what they are doing now and before, these changes relate to more trees/plants, soil quality, and less water. For both systems, soil quality was reported to be mostly better in the present ejido.

Table 14. Differences between the present solar or parcela and the previous farm.*

Difference	Solar		Parcela		Total	
	No.	%	No.	%**	No.	%**
Trees/ plants	7	64	1	6	8	30
Soil quality	3	27	5	31	8	30
Closer to town / accessibility	-	-	2	13	2	7
Less water, high evaporation, no irrigation	1	9	1	6	2	7
Better topography or terrain	-	-	1	6	1	4
Smaller area	-	-	1	6	1	4
Less profit	-	-	1	6	1	4
Have vegetable garden	-	-	1	6	1	4
Livestock	-	-	2	13	2	7
Have livestock here	-	-	1	6	1	4
Total	11	100	16	99	27	101

* Based on the number of respondents providing the information.
** Percentage column may not equal to 100% because of rounding off errors.

B. Socio-Economic-Demographic Characteristics

This section presents the characteristics of the respondents, including gender, age, educational attainment, and the number of children in the family. The respondents' major and secondary sources of family income are also highlighted. In addition to asking the respondents, their spouses were also asked regarding other sources of the family income.

B.1. Parcelas or Ranchitos

Respondents' Gender, Age, Educational Attainment and Number of Children

Except for one, all parcela respondents are males (97%) (Table 15). The group is relatively older with an average age of 55. The age range was from 29 to over 64 years. There are few "retirable" persons (65 years and older), but almost half (45%) of the respondents are within the 50-64 age bracket, followed by16% within the 40-49 age bracket and another10% under the 30-39 age bracket (Table 16). Chi-square test results indicated these ranges as significantly different than those for solar group at the 0.05 level.

The respondents' educational attainment is generally low, with almost half (43%) having no educational attainment at all. Majority of those who have been to school either have reached primary grade (37%) or have attained at least an elementary education (13%). Of the 64 respondents, only one person mentioned that he had attained an education higher than the secondary or high school level. On the average, educational attainment is Grade 3 (Table 17). The t-test results, however, indicated these were not significantly different from those for solar respondents at 0.05 level.

Table 15. Respondents' gender.

Gender	Solar		Parcela		Total	
	No.	%	No.	%	No.	%
Male	16	49	30	97	46	72
Female	17	51	1	3	18	28
Total	33	100	31	100	64	100

Table 16. Age ranges of respondents.

Age Range	Solar		Parcela		Total		X_i^2 -test
	No.	%*	No.	%*	No.	%*	
20 -29	7	21	2	7	9	14	
30-39	9	27	3	10	12	19	
40-49	7	21	5	16	12	19	
50-64	9	27	14	45	23	36	
65 +	1	3	7	23	8	13	
Total	33	99	31	101	64	101	
Average Age	41		55				**

* Total percentage may not equal to 100% because of rounding off errors.
** Significant difference in average age at 0.05 level.

Table 17. Educational attainment of the respondents.

Educational Attainment	Solar		Parcela		Total	
	No.	%	No.	%*	No.	%
No educational attainment (0)	3	9	13	43	16	25
Primary (Grades 1-4)	20	61	11	37	31	49
Elementary (Grades 5-6)	7	21	4	13	11	18
High School (Grades 7-11)	3	9	1	3	4	6
Vocational/some college units	-	-	1	3	1	2
Total	33	100	30	99	63	100
Average	3.8		2.6		ns	

* Percentage column may not equal to 100% because of rounding off errors.
ns t-test indicates no significant difference in averages at 0.05 level.

The family size of almost half of the parcela farmers are relatively big (Table 18) as 13 people (43%) mentioned having 7-9 children, six persons (17%) cited having 4-6 children, and still six farmers (17%) mentioned having10-15 kids. Only one respondent mentioned having no kids at all. The average number of children per family is 7.

Table 18. Number of children of the respondents.

Number of children	Solar		Parcela		Total	
	No.	%*	No.	%	No.	%
0	5	15	1	3	6	9
1-3	9	27	6	20	15	24
4-6	7	21	5	17	12	19
7-9	9	27	13	43	22	35
10-15	3	9	5	17	8	13
Total	33	99	30	100	63	100
Average Number of Children	4.8		7.0		**	

* Total ercentage may not equal to 100% because of rounding off errors.
** t-test indicates significant difference in averages at 0.05 level.

Major and Other Sources of Family Income

When asked about their major sources of family income, almost one half (48%) of the respondents cited farming as their number one income source, followed by instances when they are hired as farm laborers (13%). Only two persons (7%) cited their livestock as their major source of income. Table 19 presents the information about these major sources of income. When same question was asked of the farmer's spouse, farming still emerged as the family's top income source (19%), followed by forest-related sources (10%) and as farm hired laborers (7%). Forest-related sources include mostly fruits and "dormientes", a hardwood used as railroad ties. Retail business, on the other hand, include small convenience and garment store. Table 20 shows the rest of these major sources of family income as reported by the respondents' spouses.

Table 19. Major sources of family income.*

Source	Solar		Parcela		Total	
	No.	%**	No.	%**	No.	%**
Farming	7	21	15	48	22	34
As farm or hired labor	3	9	4	13	7	11
Procampo***	3	9	-	-	3	5
Forest-related sources (fruits, dormientes)	1	3	1	3	2	3
Livestock	-	-	2	7	2	3
Gardening	2	6	-	-	2	3
Remittances from other family members	1	3	1	3	2	3
Honey production	-	-	1	3	1	2
Retail business (grocery, garment)	-	-	1	3	1	2
Government job	1	3	-	-	1	2
Work at the sugar refinery	1	3	-	-	1	2
Government pension	-	-	1	3	1	2
Construction/Carpentry	1	3	-	-	1	2
Missing	13	39	5	16	18	28
Total	33	99	31	99	64	102

* This was also asked of the spouse. Please see Table 20.
** Total percentage may not equal to 100% because of rounding off errors.
*** A government-sponsored program that provides incentives to farmers to produce corn.

Table 20. Major sources of family income, as reported by respondent's spouse.

Source	Solar		Parcel		Total	
	No.	%	No.	%	No.	%
Farming	9	27	6	19	15	23
As farm or hired labor	2	6	2	7	4	6
Forest-related sources (fruits, dormientes)	1	3	3	10	4	6
Procampo*	-	-	1	3	1	2
Chicle	1	3	-	-	1	2
Remittances from other family members	1	3	-	-	1	2
Retail business (grocery, cloth/garment)	1	3	1	3	2	3
Government pension	-	-	1	3	1	2
Director (alberque)	1	3	-	-	1	2
Construction/carpentry	1	3	-	-	1	2
Missing	16	49	17	55	33	52
Total	33	100	31	100	64	100

* A government-sponsored program that provides incentives to farmers to produce corn.

For the other sources of family income, some respondents cited government-sponsored programs (19%), followed by farming (16%), and by forest-related products and as farm hired laborer (10% each). The spouses, on the other hand, echoed the same information provided by their husbands or wives by mentioning government-sponsored programs to be their other top source (13%), followed by forest-related sources (10%) and farming (7%). Tables 21 and 22 present the rest of the information on other sources of family income.

Table 21. Other sources of family income.*

Source	Solar		Parcel		Total	
	No.	%	No.	%	No.	%
Farming	4	12	5	16	9	14
Procampo**	1	3	6	19	7	11
As farm or hired labor	1	3	3	10	4	6
Forest-related sources (fruits, dormientes)	-	-	3	10	3	5
Government pension	3	9	-	-	3	5
Construction/Carpentry	2	6	1	3	3	5
Retail business (grocery, cloth/garment)	-	-	1	3	3	5
Cottage industry (embroidery)	2	6	-	-	2	3
Honey production	1	3	1	3	2	3
Livestock	1	3	-	-	1	2
Gardening	-	-	1	3	1	2
Remittances from other family members	1	3	-	-	1	2
Private job (wife works as a nurse)	1	3	-	-	1	2
Trucking business	1	3	-	-	1	2
Missing	15	46	8	26	23	36
Total	33	100	31	100	64	100

* This was also asked of the spouse. Please see Table 22.

**A government-sponsored program that provides incentives to farmers to plant corn.

Table 22. Other sources of family income, as reported by respondent's spouse.

Source	Solar		Parcel		Total	
	No.	%	No.	%	No.	%
Procampo*	2	6	4	13	6	9
Forest-related sources (fruit, dormientes)	1	3	3	10	4	6
Farming	1	3	2	7	3	5
As farm or hired labor	1	3	1	3	2	3
Livestock	-	-	1	3	1	2
Honey production	-	-	1	3	1	2
Gardening	-	-	1	3	1	2
Retail business (grocery, cloth/garment)	1	3	-	-	1	2
Trucking business	1	3	-	-	1	2
Government pension	-	-	1	3	1	2
Missing	26	79	17	55	43	67
Total	33	100	31	100	64	100

*A government-sponsored program that provides incentives to farmers to plant corn.

B.2. Solares or Home Gardens

Respondents' Gender, Age, Educational Attainment and Number of Children

In contrast to parcela respondents, solar respondents constitute 51% female and 49% male (Table 15) and their ages are almost evenly distributed under the four age range brackets presented in Table 16. It appears that there is a good mixture of young and older respondents here with almost one-fifth (21%) of them below 30 years and another one-fifth (27%) over 50 years of age. The average age of solar respondents is 41 years.

With regards to educational attainment, more than half (61%) have reached the primary grades while almost one-fifth (21%) have reached elementary level (Table 17). No one from this group has ever reached the college level. On the average, educational attainment is Grade 4.

Family size, in terms of children, did not differ much with those of the parcela respondents. Table 18 shows that over a fifth (27%) of them have 7-9 kids, 27% reported having 1-3 children and 15% mentioned to have no child at all. On the average, solar respondents have 5 children in the family.

Major and Other Sources of Family Income

Unlike the first group, only few solar respondents view farming as their major source of family income as indicated by the good spread or frequency of the major sources cited (Table 19). Of those who answered, only 21% mentioned farming, another 9% each cited farm/hired labor and government-sponsored programs, while 6% mentioned gardening. For the spouses, farming is a considered major source by 27%, followed by farm/hired labor (6%) (Table 20).

For other income sources, there is not much difference repeated when compared with the information about major sources of income mentioned earlier (Tables 21 and 22). Once again, the spread or frequency indicates the varying sources that the farmer-operators and their spouses could get their family income.

B.3. Solares vs. Parcelas

Respondents' Gender, Age, Educational Attainment, and Number of Children

With regards to gender, the respondents are predominantly male (97%) in parcelas while it is almost equally divided (51% female, 49% male) in solares. This indicates that most husbands take care of the parcela which is usually farther from home compared to the location of the solar which is near or around the residence where the wife can easily attend to while doing the household chores.

The parcela respondents are predominantly older (with an average age of 55 years) compared to solar respondents whose average age is 41 years. Chi-square test results indicated a significant differences in these age ranges between parcela and solar respondents at the 0.05 level. Education-wise, half of parcela respondents either reached the primary grade or have elementary education. In contrast, over four fifths (82%) of solar respondents have reached the primary or the elementary level. Whether there is a correlation between gender and education was not explored.

On the average, parcela respondents reported bigger families (average of 7 children) compared to solar respondents (average of about 5 children). A t-test indicated a significant difference between these two averages at 0.05 level.

Major and Other Sources of Family Income

The two areas surveyed are predominantly farm-based. Farming is considered as a major source of income by most parcela (48%) and solar (21%) respondents. Several others were mentioned by few other respondents. Responses by spouses also indicated farming as the major income source (27% solar, 19% parcela).

C. Organizational Memberships

Information on memberships in organizations in their ejidos help indicate other activities or involvement of respondents that could have some social or economic relevance. For instance, membership in an organization of producers could mean involvement in some local network of suppliers that could involve sharing of available useful information, resources, or even technology.

C.1. Parcelas or Ranchitos

The organized groups where parcela respondents are mostly members of are producers' organizations with 18 people reporting (75%) and the ejido committees with four persons reporting (13%). Two people reported being members of other organizations (8%). This "other groups" refers to organizations that were not classified under the four general categories listed in this survey (Table 23). A list of these organizations are provided in Table 24.

Table 23. General categories of organized groups with respondents' membership .*

General Categories	Solar		Parcela		Total	
	No.	%**	No.	%**	No.	%**
Producers' Organization	10	43	18	75	28	60
Ejido Committees	3	13	4	17	7	15
Womens' Group	6	26	-	-	6	13
Other Organizations ***	4	17	2	8	6	13
Total	23	99	24	100	47	101

* Only three general groupings is considered in this study.
** Percentage column may not equal to 100% because of rounding off errors.
***Other groups that are not categorized under the three general groupings considered.

Table 24 presents total number of memberships in specific organizations for the whole group of 64 respondents. Among the producers' associations, both groups of respondents mentioned the organization of sugarcane producers/planters (Union de Productores de Cana)as the most popular group (11%) followed by the wood producers group (9%) and then by the Procampo with 8% reporting as members (Table 24). Procampo is a government-sponsored program that gives incentives to farmers to plant corn (maiz). The rest of the respondents' memberships includes those in honey and chicle producers groups and the corredores groups (tree planters). A total of 15% reported memberships in various ejido committees while 13% reported memberships in the women's organization called "Unidad Agricole y Industrial de la Mujer" or UMIM.

Table 24. Types and names of organizations respondents are involved with*.

Type and name of organization	Total No.	Total %
PRODUCERS' ASSOCIATION		
Union Productores de Cana (sugarcane planters)	7	15
Wood producers association (maderables; railroad ties)	6	13
Procampo**	5	11
Organic honey producers (SARH-sponsored)	4	9
Corredores group	3	6
Chicle producers	2	4
Cattle producers	1	2
EJIDO COMMITTEE		
Different local ejido committees (eg. for ejido-ralated religious festivities)	6	13
Comisariado (as ejido deputy/delegate he is a member of a group outside local ejido)	1	2
WOMENS' GROUP		
Unidad Agricole y Industrial de la Mujer (UMIM)	6	13
OTHERS		
Local enterprises group (business; transportation)	2	4
Reyes Mejon Workers group	1	2
Society of Mayan Agriculturists	1	2
Recreational organization with a facility at Valnearrro Alvergue Obregon	1	2
Consejo Conasupo Council	1	2
Total	47	100

* Some respondents have indicated being members in more than one organization.
** A government-sponsored program that provides incentives to farmers to plant corn.

C.2. Solares or Home Gardens

For the solar respondents, almost half mentioned being members of the producers' organization (43%). It may be recalled that there were 17 female respondents for the solares. More than one-third of these are members of women's groups. Table 23 presents the rest of the respondents mentioning their memberships in either ejido committees (13%) or in other organizations (17%).

C.3. Solares vs. Parcelas

In terms of membership in various organizations, solar respondents mentioned more and varied groups than parcela respondents. However, the majority in both groups (43% in solar, 75% in parcela) reported to be members of some producers' organizations.

As expected, membership in women's organization was mentioned more by solar respondents because 97% of parcela respondents were males.

VII. CHARACTERISTICS OF AGROFORESTRY SYSTEMS

A. Biophysical Characteristics

The two systems that are characterized here are the solares or traspatio (home gardens) and the parcelas diversificadas or ranchitos (diversified farm plots).

This section presents information regarding some site characteristics, such as topography, soil types, water availability, accessibility, and distance of the site from home and the road. The choice of site for the new system, particularly the parcela, has been guided by several reasons, including the biophysical characteristics of the site, topography, and water availability. Information is also given on distance and accessibility. Home gardens have a different kind of location and have no accessibility problems. Discussions about the two systems are presented in the first two sub-sections. Some information for both systems are presented on the same table to provide comparative ideas regarding these two systems. Comparisons are presented in the third sub-section, after the two systems have been discussed.

A.1. Parcelas or Ranchitos

Site selection for the parcela was mostly based on two major reasons: better soil quality and accessibility. Other reasons given were topography and land ownership (bought, given, inherited), and proximity to relatives. This information emphasized the respondents' search for greener pastures, especially when tied up with the reasons why they move to their present ejido. Percentages are given in Table 25 below.

Table 25. Reasons for selecting present site for parcela.

Reason	Parcela	
	No.	% *
Better soil	12	43
Close to village or accessibility	7	25
Better terrain or topography	3	11
Land was purchased	3	11
Land was given	1	3
Relatives live here	1	3
Parcel of land was inherited	1	3
Total	28	99

* Total percentage may not equal to100% because of rounding off errors.

With respect to topography, parcela sites were mostly located on flat or plain land (58%) and then on rolling or undulating land or "achipotado" (26%). The others were located on sloping terrain also known as "con pendiente", and some combinations of flat, undulating, and sloping terrain (Table 26). In short, although most sites are on flat/plain lands, the topography in the area ranged from flat to rolling to gently sloping terrain.

Table 26. Topographical characteristics of solar or parcela sites.

Topographical characteristic	Solar		Parcela		Total	
	No.	%	No.	%	No.	%
Flat or plain	18	54	18	58	36	56
Rolling or undulating/archipotado	5	15	8	26	13	20
Con pendiente or sloping	6	18	2	7	8	12
Flat or plain with some undulations	3	9	-	-	3	5
Con pendiente & flat with undulations	1	3	1	3	2	3
Con pendiente with flat/plain terrain	-	-	1	3	1	2
Some parts are stony	-	-	1	3	1	2
Total	33	102	31	100	64	100

The soils in the parcelas are of different types (Table 27). Nine respondents mentioned their farm soils to be of tsek'el type which is described as black to brown rocky soil that normally includes large slabs of rock (29%). This soil type is common in higher places and is usually associated with other soil types such as chak lu'um, ak'alche,

and puus lu'um. The other soil type common is the k'ankab reported by six respondents (19%). This soil which is bright red to red to reddish brown in color is common in flat terrain at the foot of low hills. Four others (13%) cited the ya'ax hom type which is grayish black or reddish brown in color and is found usually on higher parts of flat areas. Table 27 shows the rest of the soil types found in the parcelas. The complete description of the soil types are presented in Appendix 3.

Table 27. Types of soil in solar and parcela.

Type of soil	Solar		Parcela		Total	
	No.	%*	No.	%*	No.	%
Tsek'el	15	45	9	29	24	38
K'ankab	4	12	6	19	10	16
Puus lu'um	4	12	3	10	7	11
Chak lu'um	4	12	2	6	6	9
Ya'ax hom	2	6	4	13	6	9
Combination of tsek'el and k'ankab	2	6	2	6	4	6
Combination of ak'alche and ya'axhom	-	-	3	10	3	5
Combination of chak lu'um and k'ankab	1	3	1	3	2	3
Combination of puus lu'um and k'ankab	1	3	1	3	2	3
Total	33	99	31	99	64	100

* Total percentage may not equal to100% because of rounding off errors.

Water is an important factor and 68% of parcela respondents reported some kind of water system in their site. There were 21 respondents who provided this information and who cited sources such as deep wells (47%), well with pumps (19%), and stream/brook/ lake nearby (19%). Other water sources mentioned were a water tank, faucet, and a pool or basin. It may be observed that most of these sources are dependent on natural occurrences or flows and not on energy-driven mechanisms as pumps. Additionally, parcelas are usually located farther from home as compared to the solar; thus, a more elaborate water system such as faucets could be very costly (Tables 28 and 29). In fact, there is significant difference at 0.01 level between the two groups of respondents as far as water sources are concerned, as indicated by results of a chi-square test on this matter.

Table 28. Existence of water system in solar and parcela.

Response	Solar		Parcela		Total		X_i^2 -test
	No.	%	No.	%	No.	%	
Yes	30	97	21	68	51	82	
No	1	3	10	32	11	18	
Total	31	100	31	100	62	100	*

* Significant difference in means at 0.01 level.

Table 29. Water sources for the solar and parcela.*

Source	Solar		Parcela		Total	
	No.	%	No.	%	No.	%
Potable (faucet)	29	94	-	-	29	55
Deep well	1	3	10	47	11	21
Well with pump	-	-	4	19	4	8
Stream, brook, or lake	-	-	4	19	4	8
Water tank	-	-	1	5	1	2
Faucet	-	-	1	5	1	2
Cistern	1	3	-	-	1	2
Pool or basin	-	-	1	5	1	2
Total	31	100	21	100	52	100

* Based on those who have a water system on their solar or parcela.

Parcelas are, on the average, almost 3 kilometers away from the respondents' homes, about 1.7 kilometers from the nearest main road, and one kilometer from a dirt road. Travel time is slightly over 30 minutes walking or less than 20 minutes if on horseback. Many respondents just walk to the site (Table 30).

Table 30. Average travel time (in minutes) from home to parcela. (Asked of the parcela respondents only).

Means of travel	
By foot/walking:	
time	31.4
range	1.8 - 18.0
N*	15
By horse:	
time	18.6
range	0 - 60
N*	13
By car:	
time	14.8
range	4.8 - 19.8
N*	3
Combination of the above	
time	19.9
range	19.8
N*	1

* N refers to the number of respondents providing the information.

A.2. Solares or Home Gardens

The topographical characteristics of solar or home garden sites were very similar to those reported for parcelas (Table 26). Most solares were sited on flat or plain land (54%). They were also located on sloped (con pendiente) lands (18%) and then on rolling or undulating land (15%). Others were sited on terrain with various combinations of flat, undulating, and sloping terrain. Again, this information indicate the general topography of the region, which is mostly flat and undulating, with some rolling/undulating and sloping terrain.

With regards to the type of soil, almost half of them mentioned that their farm soil is mostly of the tsek'el type (45%). Table 27 also shows the other three most common types as k'ankab, puus lu'um, and chak lu'um as reported by four respondents each (12%, respectively). The puus lu'um is a loose soil type with brown to dark grey color and is mostly found on high parts of hills while the chak lu'um is red to reddish brown in color and is also found on high parts of hills.

Almost all solar respondents (97%) reported a water system in their site (Table 28). The major water source is the faucet (94%)

which is also a potable water source (Table 29). One respondent each mentioned a deep well and a cistern as their water sources. It may be mentioned that the solar or home garden is close to the home or even surrounds the house of the respondent, hence faucets are very common.

A.3. Solares Vs. Parcelas

While the choice of location for the parcela seemed to be governed by certain factors, solares are more or less associated with where residences are located. However, both systems are mostly located on plain or flat lands (56% of respondents provided this piece of information), and then on rolling/undulating (20%) and sloped lands (12%). A water system is present for most systems, with a higher percentage reported for solares (97%) than for parcelas (68%) and which was found significantly different in a chi-square test at the 0.01 level. This is understandable, considering the location of the home gardens. The type of water system existing in the solar (faucets) and the parcela (deep wells, streams) also helps explain this significant difference. Finally, while parcelas may have an accessibility disadvantage for being located farther (about 3 kilometers) from home, there was no indication of a distance problem.

B. Establishment Phase

This section presents the various variables relating to the establishment and development of the two systems. Included in this portion are the reasons for establishing a particular system, from whom or where the respondents learned about the system, the original status or condition (or prior use) of the land where the system is sited, and the original system components (trees, crops, animals) and the quantities that were planted or brought into the system when it was established. Also included are some long term plans regarding components that the respondents would like to have on their system. Discussions will be presented by system first. Some information for both systems will be presented on the same table to provide comparative ideas regarding these systems. The first two sub-sections are discussions regarding the two systems. The third sub-section presents a comparison of the two systems in terms of selected variables.

B.1. Parcelas or Ranchitos

Reasons for Developing, Source of Original Idea, and Prior Use/Status of Land

There were several reasons provided for developing the parcela (Table 31). Two major reasons can be gleaned from their responses: work opportunities provided (31%), and because the land was given by relatives, including family (28%). The other reasons are better production or marketing (14%), for subsistence (11%), location of the residence (6%), and influenced by others (6%). One each responded that the land was given by the government and that it also gave the opportunity to raise livestock.

Table 31. Major reasons for developing the systems.

Major reason	Solar		Parcela		Total	
	No.	%*	No.**	%*	No.	%
Work or employment	5	16	11	31	16	24
Given by relatives	4	13	10	28	14	21
Residence located in the area	10	32	2	6	12	18
For subsistence	3	10	4	11	7	10
Farm production or marketing okay	2	7	5	14	7	10
Given by the government	2	7	1	3	3	4
Was influenced by others	-	-	2	6	2	3
Animal production/ protection	2	7	1	3	3	4
For fruit and shade	1	3	-	-	1	2
The land was purchased	1	3	-	-	1	2
For improved quality of life	1	3	-	-	1	2
Total	31	101	36	102	67	100

* Total percentage may not equal to 100% because of rounding off errors.
** Total number of parcela respondents exceeds 31 because some respondents provided more than one reason for developing their parcela.

The original idea for developing the parcela came from at least four sources (Table 32). In the main, the idea was primarily based on their own experience or was a part of family tradition (64%). This is not surprising because, as cited earlier in this report, most of the respondents have a farming background and were exposed to agricultural activities at an early age. This also implies that the parcela system is a traditional one that has been practiced by generations. The government, especially SARH or the equivalent of the U.S. Forest Service, was another important source of information as mentioned

by six respondents (21%). The SARH has been encouraging the planting of trees in the country, as mentioned earlier. The other two sources were agroforestry projects (7%) and other ejidatarios (7%).

Table 32. Sources of the idea regarding the parcela.

Source of the idea	Solar		Parcela		Total	
	No.	%*	No.	%*	No.	%*
Family and/or own experience	22	85	18	64	40	74
The government	1	4	6	21	7	13
From agroforestry project technicians	-	-	2	7	2	4
Other established solar	2	8	-	-	2	4
Land is just given as gift	1	4	-	-	1	2
Other ejidatarios/organization	-	-	2	7	2	4
Total	26	101	28	99	54	99

*Total percentage may not equal to 100% because of rounding off errors.

Before they were developed into a parcela, most sites originally were either "acahual" or under fallow/secondary vegetation (45%) or forest (31%). Two sites (7%) were "milpa" (where the "rosa-tumba-quema" or slash-and-burn activities were undertaken), while the rest were various combinations of forest, "acahual", and pasture. This information implies removal of some vegetation or cover to give way to some crops, including the introduction of the desired tree species. Table 33 presents the various uses or status of the land prior to the development of the site into a parcela.

Table 33. Original state of the site when respondents started out farming.

Response	Solar		Parcela		Total	
	No.	%	No.	%*	No.	%
Acahual	10	38	13	45	23	42
Forest	11	42	9	31	20	36
Pasture	1	4	1	3	2	3
Nothing	3	12	1	3	4	7
Milpa	-	-	2	7	2	4
Combination of forest & pasture	-	-	1	3	1	2
Abandoned solar or pasture	1	4	-	-	1	2
Combination of forest & acahual	-	-	1	3	1	2
Combination of pasture & acahual	-	-	1	3	1	2
Total	26	100	29	98	55	100

*Total percentage may not equal to 100% because of rounding off errors.

Components of the System When First Established

The respondents were asked about the existence of trees, crops, and animals that they have planted or raised within their parcelas. A list was generated of each component to determine the species, the popularity of each species for planting by the respondents, and the average count or quantity that was placed into the system. The information presented in this section is based only on those who reported as having planted, raised, or included these components in their system.

The lists of species and the number and percentage of respondents reporting each species are presented in Tables 34 through 36 for trees, non-tree crops or cultivars, and animals, respectively. The average number planted of various tree species and the average number of animal species brought in are presented on Table 37 and Table 38, respectively. These numbers were the best estimates given by the respondents from their best recollection. For the crops, no numbers were given, possibly because it was the most difficult for respondents to recall.

For the trees (Table 34), the 10 most popular species planted in the parcela and the percentage of respondents reporting as having planted these are as follows: naranja dulce (52%), mango (48%), coconuts (42%), limon (35%), avocado (35%), naranja agria (32%), mandarina (32%), anona (32%), mamey (29%), and nance (29%). Other non-fruit tree species were also mentioned by fewer respondents, such as cedro (cedar), caoba (mahogany), and roble. There was a total of 41 tree species that were mentioned by the respondents in this survey. For the scientific names of these species, please refer to Appendix 4.

With regards to the number of trees planted (Table 37), the high averages were reported for naranja dulce (158 trees), cedro (239), jabin (100), mandarina (50), coconut (46), and naranja agria (37). This information, however, could be misleading and the reader is cautioned to be careful in taking in this information, and is directed to look at the number of respondents reporting as well to get a clearer picture of what species are predominant in the parcelas. For instance, there was only one respondent who reported planting 100 jabin trees while there were 13 individuals who reported planting an average of 46 coconut trees and nine people reporting an average of 50 mandarina trees. It is apparent, however, that the most popular fruit tree species (naranja dulce) was possibly planted

on a larger scale compared to the others, while the cedro could be planted in a small-scale tree plantation. For most of these species, significant differences between the two groups or systems were reported at 0.05 level (Table 37).

For the non-tree crops or cultivars (Table 35), the top six species that were planted and the percentage reporting of each species are as follows: corn (39%), squash (26%), pepper (19%), frijol or beans (19%), bananas (16%), and chaya (10%). These species are common throughout most of the region. The total number of cultivars reported was 18. There was no information on the quantity of crops planted when the parcela was first established (Table 35).

For the animal species (Table 36), only seven respondents reported having brought them into the area when they established the parcela. The four animals that were mentioned are: chickens (6%), sheep (6%), bees (6%), and hogs (3%). This information indicates that animals are not very popularly raised in the parcelas, perhaps because of the distance of the site from home as it relates to the management and security (from thieves) of these animals. Surprisingly, however, there was a high average number for sheep (35 heads), chickens (15 heads), and beehive boxes (11) that were brought into the area as shown in Table 38. Two of those who reported as having animals in the area did not provide a count of the animals brought in. T-test results indicated significant differences at 0.05 level in the number of chicken (and in the number of sheep) reported for the solares and the parcelas.

Table 34. Tree species planted by respondents at time of establishment of the system.*

Tree species	Solar		Parcela		Total	
	No.	%**	No.	%**	No.	%
Sweet Orange/Naranja Dulce	20	61	16	52	36	60
Coconut	11	33	13	42	24	40
Avocado/aguacate	12	36	11	35	23	38
Limon	12	36	11	35	23	38
Mango	8	24	15	48	23	38
Mamey	9	27	9	29	18	30
Orange/Naranja Agria	7	21	10	32	17	28
Ciruela	8	24	8	26	16	27
Mandarin	6	18	10	32	16	27

Table 64 continued next page...

Table 34. . . Continued.*

Tree species	Solar		Parcela		Total	
	No.	%**	No.	%**	No.	%
Guanabana	7	21	8	26	15	25
Anona	4	12	10	32	14	23
Guaya	9	27	5	16	14	23
Nance	5	15	9	29	14	23
Caimitillo	5	15	7	23	12	20
Guayaba	6	18	5	16	11	18
Zapote	7	21	4	13	11	18
Tamarind	7	21	3	10	10	17
Toronja	6	18	3	10	9	15
Cedro	4	12	4	13	8	13
Guano	1	3	7	23	8	13
Saramuyo	4	12	4	13	8	13
Ramon	4	12	2	6	6	10
Jicaro	4	12	1	3	5	8
Roble	2	9	3	10	5	8
Achiote	1	3	3	10	4	7
Siricote	3	9	1	3	4	7
Caoba	1	3	3	10	4	7
Almendro	-	-	3	10	3	5
Jabin	2	6	1	3	3	5
Coyol	1	3	2	6	3	5
Corozo	1	3	1	3	2	3
Pimienta	1	3	1	3	2	3
Granada	1	3	-	-	1	2
Grosella	1	3	-	-	1	2
Maranon	1	3	-	-	1	2
Balche	-	-	1	3	1	2
Chacte	-	-	1	3	1	2
Granadillo	-	-	1	3	1	2
Piche	-	-	1	3	1	2
Chaca	1	3	1	3	1	2
Guacimo	1	3	-	-	1	2
Limonaria	1	3	1	3	1	2
Tronador	-	-	1	3	1	2
Yaiti	-	-	1	3	1	2
Yaxnic	-	-	1	3	1	2
Bojon	1	3	-	-	1	2
Sihiriox	1	3	-	-	1	2
Mamoncillo	1	3	-	-	1	2
Ninuya	1	3	-	-	1	2
Total Number of species mentioned	41		41		49	

* Based on tree species mentioned by respondents.

** Percentage is based on the total number of respondents per group, 33 for parcela and 31 for solar. For example, 20 individuals (61% of all solar respondents) and 16 people (52% of all parcela respondents) reported having planted sweet orange in their systems.

Table 35. Non-tree crops (cultivars) planted by respondents during establishment of the system.*

Non-tree species	Solar		Parcela		Total	
	No.	%**	No.	%**	No.	%
Corn	8	24	12	39	20	33
Squash	4	12	8	26	12	20
Frijol	6	18	6	19	12	19
Pepper	3	9	6	19	9	15
Banana	2	6	5	16	7	12
Watermelon	3	9	2	6	5	9
Chaya	1	3	3	10	4	7
Sweet Potato	2	6	2	6	4	7
Cacahuate	2	6	1	3	3	5
Cilantro	1	3	2	6	3	5
Pepino	2	6	1	3	3	5
Napoles	-	-	2	6	2	3
Pineapple	-	-	2	6	2	3
Yuca	1	3	1	3	2	3
Chayote	-	-	1	3	1	2
Rabano	-	-	1	3	1	2
Jicama	-	-	1	3	1	2
Sugarcane	-	-	1	3	1	2
Total Number of Species mentioned	12		18		18	

* Based on the non-tree crop species mentioned by respondents.

** Percentage is based on the total number of respondents per group, 33 for parcela and 31 for solar. For example, eight individuals (24% of all solar respondents) and 12 people (39% of all parcela respondents) reported having planted corn in their systems.

Table 36. Animal species brought in by respondents during establishment of the system.*

Animal species	Solar		Parcela		Total	
	No.	%**	No.	%**	No.	%
Chicken	10	30	2	6	12	20
Turkey	8	24	-	-	8	13
Pig/Hog	6	18	1	3	7	12
Sheep	2	6	2	6	4	7
Bee/Beehive	-	-	2	6	2	3
Duck	2	6	-	-	2	3
Total Number of Species mentioned	5		4		6	

* Based on the animal species mentioned by respondents.

** Percentage is based on the total number of respondents per group, 33 for parcela and 31 for solar. For example, 10 individuals (30% of all solar respondents) and two persons (6% of all parcela respondents) reported having brought chicken in in their systems.

Table 37. Average number of trees planted by respondents at time of establishment of the system.

Trees	Solar		Parcela		t-test
	N*	Ave.	N*	Ave.	
Achiote	1	2.0	3	19.7	**
Aguacate	11	3.0	10	16.1	ns
Anona	3	3.3	10	6.8	ns
Caimitillo	4	1.3	7	3.7	ns
Ciruela	6	2.8	8	8.5	ns
Coconut	9	6.4	13	45.8	**
Coyol	1	1.0	2	1.0	**
Corozo	-	-	1	40.0	---
Garnada	1	10.0	-	-	---
Guanabana	6	6.0	8	8.6	ns
Guaya	8	1.8	5	10.8	ns
Guayaba	5	1.2	5	4.6	**
Limon	11	1.9	11	18.7	ns
Mamey	8	1.5	9	5.0	**
Mandarina	5	3.2	9	50.6	ns
Mango	7	2.2	11	11.7	**
Nance	4	1.3	9	8.8	**
Naranja Agria	6	5.2	8	36.6	ns
Naranja Dulce	17	12.8	13	157.5	**
Pimienta	1	2.0	1	10.0	**
Saramuyo	3	2.3	4	4.0	ns
Tamarindo	5	2.2	2	3.0	**
Toronja	5	1.8	3	3.3	ns
Zapote	6	1.7	4	3.8	**
Caoba	-	-	3	6.0	---
Cedro	2	2.0	4	238.5	**
Chacte	-	-	1	30.0	---
Negrito	-	-	1	5.0	---
Roble	2	1.0	3	8.7	**
Siricote	2	1.0	1	4.0	**
Chaca	1	1.0	1	10.0	**
Ramon	3	3.0	2	1.0	**
Almendro	-	-	13	1.3	---
Guano	1	4.0	6	29.5	**
Jabin	2	1.0	1	100.0	**
JIcaro	3	2.7	1	2.0	**
Limonaria	1	2.0	1	1.0	**
Yaiti	-	-	1	30.0	---
Yaxnik	-	-	1	20	---
Ninuya	1	3.0	-	-	---

* N refers to the number of respondents providing the information.
** Significantly different at 0.01 level.
ns Not significantly different at 0.01 level.

Table 38. Average number of animals brought in by respondents at time of establishment of the system.

Animal species	Solar		Parcela		t-test
	N*	Ave.	N*	Ave.	
Chicken	4	18.5	1	15.0	**
Turkey	3	5.0	-	-	---
Sheep	1	45.0	2	35.0	**
Bee/Beehive	-	-	2	10.5	---
Duck	2	4.5	-	-	---
Pig/Hog	1	3.0	-	-	---

* N refers to the number of respondents providing the information.
**Significantly different at 0.05 level.

Time When Crops and Trees Are Planted or Animals Are Brought In

Generally, the rainy or wet season is the best time for planting crops and trees in Southeastern Mexico. The wet season is a three-month period that starts in September and ends in November. However, it is also common to see farmers planting earlier than September. In fact, some farmers have reported planting in May, June, July, and August, although no specific crops were mentioned in association with these months. As a rule, planting of crops is very much dependent on precipitation or rain.

Even within the rainy season, some respondents also mentioned considering the position of the moon (new moon, full moon) when making their decision when to plant. However, there seems to be no uniform schedule for planting specific crops, because most of the time this activity is very much dependent on nature.

Animals were reported to be brought in any time. This and the earlier information presented in this section also holds true for the planting activities in the solar.

On spacing of trees in the system, information has been obtained on various spacings that respondents are following in their systems. The distribution of respondents who reported this information is given in Table 39. Interested readers should be aware that this information could not be associated with any specific tree species, and that this available information only shows the preponderance of farmers using a particular spacing between trees in his/her parcela or solar. For parcela respondents, more farmers

were having 5-meter or a 7-meter spacing between the trees if these trees were aligned which is similar to a 5m x 5m or a 7m x 7m spacing situation.

Table 39. Spacing between tree species, in meters.

Spacing (meters)	Solar		Parcela		Total	
	No.	%	No.	%	No.	%*
2	3	16	-	-	3	7
3	2	11	-	-	2	5
4	3	16	1	4	4	9
5	5	26	7	29	12	28
6	2	11	4	17	6	14
7	3	16	9	38	12	28
8	-	-	2	8	2	5
10	1	5	1	4	2	5
Total	19	100	24	100	43	101

* Total percentage may not equal to 100% because of rounding off errors.

Sources of Plant/Animal Stock, Sources of Knowledge About the Components

Information on the sources or where respondents get their planting materials and animal stock is presented on Table 40. Most parcela respondents generally purchased (28%) or produced their own planting stock (28%). Other sources mentioned were agro-forestry project technicians (14%), government sources (10%), another milpa (10%), and other ejidatarios (3%). For the animal stock, only one reported on this and the person has brought in his/her own stock into the area.

A very important factor is the source of knowledge of raising various components of the system (Table 41). Of the 26 people reporting, half mentioned family knowledge as their source of such knowledge. In combination with other sources (government, foreign researchers, fellow farmers/agriculturists), this percentage rises from 50% to 58%. Two other sources of knowledge that were mentioned were the government (27%) and fellow farmers/agricul-turists (11%). A very important implication here is that there is a perpetuation of the traditional methods of raising crops, trees, and animals. Subsequently, this also has implications on the knowledge of various mixes of crops, trees, and/or animals (or agroforestry variations) that these respondents have known and have brought to

the new ejido. This points to another researchable question: are there possible agroforestry systems, and if so in what variations, could there be existing in their previous ejidos or regions?

Table 40. Sources of planting and animal stock for the two systems.

Source	Solar		Parcela		Total	
	No.	%*	No.	%*	No.	%*
Own planting stock	9	29	8	28	17	28
Purchased	5	16	8	28	13	22
Other ejidatarios	9	29	1	3	10	17
Another plot or milpa	2	6	3	10	5	8
Agroforestry project technicians	1	3	4	14	5	8
Government sources	2	6	3	10	5	8
From the forest	1	3	-	-	1	2
From relatives	1	3	-	-	1	2
Own animal stock	-	-	1	3	1	2
Purchased animal stock	1	3	-	-	1	2
Total	31	98	29	96	60	99

* Total percentage may not equal to 100% because of rounding off errors.

Table 41. Sources of knowledge about trees, crops, and animals.

Source	Solar		Parcela		Total	
	No.	%	No.	%*	No.	%
Family knowledge	23	88	13	50	36	69
-and government	1	4	1	4	2	4
-and from animal research team from the USA	-	-	1	4	1	2
-and government & fellow farmers/agriculturists	-	-	1	4	1	2
Government	2	8	7	27	9	17
Fellow farmers and agriculturists	-	-	3	12	3	6
Total	26	100	26	101	52	100

* Total percentage may not equal to 100% because of rounding off errors.

Long Term Plans Regarding Components Desired For Inclusion in the System

It is very important to note that respondents also have some long term plans regarding components they want to include in their system over time. More importantly, almost all parcela respondents (90%) have such plans, as compared to only 40% of solar respondents, the difference of which is significant at the 0.01 level (Table 42). Possible reasons for this difference are discussed during the third sub-section of this particular section. Specifics of these plans will be discussed in the later section dealing with Plans and Problems.

Table 42. Existence of long-term plans regarding desired plants and animals for inclusion in the two systems.

Response	Solar		Parcela		Total		X_i^2 -test
	No.	%	No.	%	No.	%	
Yes	12	40	28	90	40	66	
No	18	60	3	10	21	3	
Total	30	100	31	100	61	100	*

* Significantly different at 0.01 level.

B.2. Solares or Home Gardens

Reasons for Developing, Source of Original Idea, and Prior Use/Status of Land

The most obvious reason for developing the solar was because the residence was located in the area (32%). Other important reasons were opportunities for work (16%), area was given by relatives (13%), and for subsistence (10%). One or two respondents also provided such answers as better production/marketing, animal production/better protection, area was given by government, for fruit/shade, land was bought, and for improved quality of life. Table 31 shows the information regarding these reasons.

The main idea for developing a solar was based on respondent's own experience or the family (85%). Three other sources were mentioned: other solar (8%), government (4%), and area was given as a gift (4%). Like the parcela, this information emphasized that this system is a highly traditional one, with information or knowledge being handed down from one generation to the next.

Eighty percent of the sites that were developed into a solar were previously either forest (42%) or "acahual" lands (38%). Other previous condition of the sites were as pasture, abandoned solar or pasture, and just wasteland. Table 33 presents this information on previous state of the land before being developed into a solar.

Components of the System When First Established

Solar respondents were also asked about the components (trees, crops, and animals) that were planted or raised within their solar. Again, information presented in this section is based only on those who reported and provided figures for these components based on their best recollection. The lists of species and the number and percentage of respondents reporting each species are presented in Tables 34 for trees, 35 for non-tree crops, and 36 for animals. The average number planted of various tree species and the average number of animal species brought in are presented on Table 37 and Table 38, respectively.

The tree component included both fruit and timber trees. For the trees, the top 12 species that were commonly planted and the percentage of respondents reporting are as follows: naranja dulce (61%), limon (36%), avocado (36%), coconuts (33%), guaya (27%), mamey (27%), ciruela (24%), mango (24%), naranja agria (21%), tamarindo (21%), guanabana (21%), and zapote (21%). It is interesting to note at this point that all these species are fruit trees. However, the respondents have also mentioned some timber trees, such as cedro, roble, and caoba. For the scientific names of these species, please refer to Appendix 4. There was a total of 41 tree species that were mentioned by the respondents in this survey.

With regards to the number of trees planted, the averages reported for the more popular species are as follows: naranja dulce (13 trees), coconut (6), guanabana (6), naranja agria (5), mandarina (3), avocado (3), ciruela (3), mango (2), guaya (2), limon (2), and mamey (2). From this information, the naranja is the predominant tree in the solar, followed by coconut and guanabana. The data also imply that it may be common to see 2-3 trees of the other popular species in the solar. The information on averages should be paired with the numbers reporting for any species to have a better picture of the predominant tree species in the solar. As an example, there is a big difference between the average number reported for granada (10) that was planted only by one person, as compared to an average of 2 limon trees but reported by 11 people.

For the non-tree crops or cultivars, there was a total of 12 species reported. The top five species that were planted and the percentage reporting of each species are as follows: corn (24%), frijol or beans (18%), squash (12%), pepper (9%), and watermelon (9%). The other seven species were: bananas, sweet potato, cacahuate or peanuts, pepino or cucumber, cilantro, chaya, and yuca. All these species are very common throughout most of the region. There was no information on the quantity of crops planted when the parcela was first established.

For the animals brought into or raised within the solar, there were 28 cases reported that involved 5 animal species. These animals and the percentage of respondents reporting are as follows (in decreasing order): chickens (30%), turkeys (24%), hogs (18%), ducks (6%), and sheep (6%). When asked about the numbers brought in, only 11 respondents provided the information. From these limited data, and if based on the respondents reporting, it seemed that fowls were more plentiful compared to livestock (averages: 19 chickens, 5 turkeys, 2 ducks). One respondent reported bringing in 45 heads of sheep and another reported having three hogs when they first established their solar. From personal observations, however, fowls, hogs, and cattle are very common in the survey areas.

Time When Crops and Trees Are Planted or Animals Are Brought In

Planting of trees and crops was generally done in the rainy season which is from September to November. However, the planting activity is very much dependent on precipitation, and thus some farmers start planting even in May until August. Especially where watering systems are close, planting was conducted even outside of the rainy season. The position of the moon also is additional information that some farmers take into account when making decsions on when to plant. With regards to the animal component, these could be brought in any time of the year. For more details about this sub-section, please refer to the same sub-section under "Section C2. Parcelas or Ranchitos".

On spacing of trees in the solar, more farmers were having 5m x 5m spacing situation. The spacing in the solar is sometimes more close compared to the parcela, suggesting more trees on a per hectare basis (Table 39).

Sources of Plant/Animal Stock, Sources of Knowledge About the Components

Solar respondents have three major sources of their planting material stock: their own stock (29%), other ejidatarios (29%), and purchases (16%). Other sources of their planting stock that were mentioned by one or two respondents are the following: government, another milpa, relatives, and agroforestry technicians. For the animal stock, only one respondent indicated purchasing the animal stock brought into the solar. This information is presented on Table 40.

The respondents' most common sources of knowledge in raising various components of the system is the family (88%). The other source of information is the government (Table 41). Again, as in the case of the parcela, the most important implication of this very high percentage for family as source is the perpetuation of the traditional technologies of raising crops, trees and animals. That the government is the only other source mentioned is indicative of the important role that public agencies can possibly play in introducing more variety into the solar sites in terms of species.

Long Term Plans Regarding Components Desired For Inclusion in the System

More than half (60%) of solar respondents do not have long term plans for their home gardens (Table 42). This may not be surprising considering the nature of the home garden: it is usually developed within residential areas. This could be seen two ways: (a) this could mean lesser variation in the trees or crops and combinations that could be planted in these more restricted areas, or (b) there have already been traditional species that have been selected and liked by the family through time, thus changes are not very likely. Furthermore, the home garden is usually not the major source of produce for the family, although they are developed for additional food for subsistence.

B.3. Solares Vs. Parcelas

Reasons for Developing, Source of Original Idea, and Prior Use/Status of Land

The main difference between these two systems is that solar is a system usually developed within or near residential areas, while parcelas are developed in sites farther away. Other differences are

that parcelas are more important as a source of employment opportunities (there were twice as many respondents in parcela who mentioned this), and also were more common as gifts from relatives compared to the solar. About the same number of respondents provided other reasons common to both systems, such as the subsistence function of the systems, better production/marketing, and animal production/protection were also mentioned.

Both systems may be categorized as traditional systems, being based mainly on family tradition or on the respondents' own experience. It may be recalled that most respondents have been exposed to or have some background in agricultural activities very early in their lives. In this sense, they are mainly implementing what they have learned and experienced throughout. It is also possible that they have made some changes as they go along, thus adaptations could occur. At this point, however, the most important thing is that the bulk of their knowledge of the trees, crops, and/or animals that they have raised was based on traditional knowledge.

There is not much difference in the previous states of the land before they were developed into either a parcela or a solar. The most common land condition or states were as forests and as "acahual". One difference was that this percentage (of forest and "acahual") is higher for solar (80%) as compared to the parcela (76%). Another difference is that milpa systems have only been reported as being re-developed as parcelas and not as solar. An expected observation that was not apparent from this data was one based on the assumption that the previous state of the land could have been dictated by factors that influence the choice of a residential area (therefore the possible solar location).

Components of the System When First Established

The tree species found in the two systems were almost similar, as can be seen in the list of the top 12 more popular species for each system, as based on the number of people who reported planting these species. For the parcela, the top 12 species were: naranja dulce, mango, coconuts, limon, avocado, naranja agria, mandarina, anona, mamey, nance, guanabana, and ciruela. For the solar, the top 12 species were: naranja dulce, limon, avocado, coconuts, guaya, mamey, ciruela, mango, naranja agria, tamarindo, guanabana, and zapote. Naranja is number one in both systems, and that all trees are fruit trees.

The number of people who have reported planting trees in both systems also vary but with no definite trend. For instance, in Table 34, comparing the two N columns will reveal that this number could be about the same in both systems for some species, slightly higher for others, or sometimes slightly lower for other trees. The big difference could be gleaned from a comparison of average number of trees being planted in Table 37. The average number of trees planted are higher for most tree species in the parcela than in the solar. In fact, t-test results indicate this difference to be significant at the 0.01 level for 18 species. The average number of forest or timber trees, such as cedro, chaca, roble, and caoba that have been planted in the parcela is much higher as compared to the solar. One implication could be that there are more spaces available in the parcela than in the solar for the tree components.

With respect to the non-tree crops, there were more cultivars in parcelas (18 species reported) than in the solar (total of 12 species reported). This implies greater variety of combinations in the parcelas, that is, parcelas are a more complex system. The two systems did not vary much in terms of the more popular species of cultivars. Based on those reporting, the top 5 species for the parcela were: corn, squash, pepper, frijol or beans, and bananas. For the solar, the top 5 species were: corn, frijol or beans, squash, pepper, and watermelon. Based on Table 35, even the top 10 species are still about the same for both systems.

The animals found in both systems did not vary much (Table 36). Both systems have chickens, hogs, and sheep. There were no turkeys nor ducks in the parcela, but bees were raised there for honey. The numbers involved for these animals, however, were small enough.

Time When Crops and Trees Are Planted or Animals Are Brought In

Planting is generally done in the rainy or wet season (September to November) for both systems. Because this activity is dependent on the precipitation, some farmers plant even as early as May. There is no specific time for planting crops, as it is dependent on the rain. Lunar positioning is also reckoned with in planting decisions. Animals were brought into the system at any time.

Spacing information showed that there is much closer spacing for trees in the solar than in parcelas, in general. This may have been influenced by the general size of the area -- most solar sites are

much smaller, usually less than a hectare, compared to a parcela which is usually 1 to 5 hectares or more.

Sources of Plant/Animal Stock, Sources of Knowledge About the Components

With respect to the sources of their planting materials (Table 40), almost 30% of the respondents in both systems rely on their own planting stock. The only difference is that, for the next major source, more parcela respondents (28%) bought the materials while solar respondents rely on other ejidatarios (29%) for these materials. This is understandable if one will consider that a greater quantity of planting materials is probably necessary in the parcela as compared to the material requirements in the solar. For the third major source, parcela respondents go to agroforestry technicians (10%) while solar respondents buy these materials (16%). For the animal stock, one parcela respondent reported using his/her own stock while a solar respondent bought the stock that was brought into the area.

Majority of the respondents in both systems reported the family/own experience as the source of knowledge about the trees, crops, and animals (Table 41). This percentage is very high for the solar respondents (88%) as compared to the parcela respondents (62%), indicating that the latter have other sources of information. The high percentage also indicates the nature of the two systems as far as technology is concerned, that is, both systems may be considered traditional with information handed down from one generation to the next within the family. However, parcela respondents reported other sources of information not cited by solar respondents, such as fellow farmers/agriculturists and a research team from the USA. Moreover, the former have more contact with government agencies compared with the solar respondents.

Long Term Plans Regarding Components Desired For Inclusion in the System

While most of the parcela respondents (90%) have long term plans regarding what they want to be included in their system, most solar respondents (60%) do not have such plans. A chi-square test indicated that there is a significant difference (0.01 level) between these two groups of respondents. This difference is understandable if we consider that, in the home garden, there could have been pre-selected traditional species that the family prefers and thus changes are not likely to occur. Second, there may be a more limited space

for more components but that trees (usually fruit trees) are the most prominent component and are more or less permanent fixtures in the solar. Another way of looking at this is by simply considering that there may be a greater variety of crops and trees and their combinations that could possibly be implemented in a parcela but that are less likely to happen within a solar.

C. Intermediate Phase

This section presents information regarding the changes that respondents have made in their system. Specifically, they were asked whether or not they have made changes in their systems or practices after the first year after establishment. If they replied in the affirmative, they were queried further as to what these changes were in each component, i.e., to trees, crops, and animals. Then they were asked when and why they made such changes, and where they got the ideas that made them modify things within their systems.

These changes and when they happened are important in order to get a better picture of how the systems have changed over time. The researchers realized that these events or changes may be very difficult to pin down specifically, so the respondents were requested to give only their best recollection of these changes.

Examples of the changes were modifications in crop diversification, tree species, animal components, water systems, use of chemicals/fertilizers and other resources, product processing and sale/marketing, sources of ideas about these changes, and others. Information will be presented by system, and then a comparison of the two systems is also included as the last sub-section of this section. In most instances, information for both systems for a particular topic is presented in one table for easier reference and for convenient comparison later. The information presented in this section are presented in several tables, from Table 43 up to Table 58.

C.1. Parcelas or Ranchitos

Changes Made After the First Year of System Establishment

When respondents were asked whether or not they have changed the size or area of their parcela, over half (55%) replied positively. However, the change (increase or decrease) could not be ascertained because of the way the question was asked. Nevertheless, related results (e.g., changes that are discussed below)

and additional comments pointed to possible increase (rather than decrease) in size. However, there is no way of telling how much that increase was (Table 43).

Table 43. Whether size of the parcela was increased or decreased.

Response	Solar		Parcela		Total	
	No.	%	No.	%	No.	%
No	23	70	12	39	35	55
Yes	4	12	17	55	21	33
Not applicable	2	6	-	-	2	3
Missing	4	12	2	6	6	9
Total	33	100	31	100	64	100

When asked if they have made changes on the system's components after the first year of establishment, the majority (87%) of the parcela respondents replied positively (Table 44). These changes are on the tree, crop, and/or animals in the system. There were no significant differences between the number of ranchito and solar respondents who replied in the affirmative (as well as in the negative), based on chi-square test at 0.01 level.

For modifications referring to the tree component (Table 45), six changes were reported by a total of 24 respondents. The majority (58%) cited that they planted more trees or replanted trees or increased (diversified) the tree species in their areas. Another 21% reported they have cut down some trees and cleaned the area. This particular reason may have something to do with the tree replantings that were reported (the number one change made). One or two respondents also reported the following changes: stopped growing certain species, application of fertilizer or pesticides, installation of a water system, and another unspecified change. Most respondents have done these changes all the time since they started (39%), and this may be the single most important information for timing or schedule. Over half (55%) of those who responded said they did these changes during the last 10 years, but because we really do not know when their systems started, all that can be said here is that there have been more changes in the tree components during the last five years.

Table 44. Whether anything was changed in the parcela after the first year of farming.

Response	Solar		Parcela		Total		X_i^2 -test
	No.	%	No.	%	No.	%	
Yes	25	76	27	87	52	81	
No	8	24	4	13	12	19	
Total*	33	100	31	100	64	100	ns

ns No significant difference in means at 0.05 level.

Table 45. Changes made in the tree component of the two systems.

Type of change	Solar		Parcela		Total	
	No.	%	No.	%*	No.	%*
Diversification /plant / replant	20	87	14	58	34	72
Cut down some trees / clean the area	2	9	5	21	7	15
Applied fertilizer / pesticides	1	4	1	4	2	4
Stopped growing certain crops/plants	-	-	2	8	2	4
Installed water system	-	-	1	4	1	2
Others	-	-	1	4	1	2
Total	23	100	24	99	47	99

* Total percentage may not equal to 100% because of rounding off errors.

Table 46. Year when changes in the trees were undertaken.

Year	Solar		Parcela		Total	
	No.	%	No.	%	No.	%
All the time since starting	8	47	7	39	15	43
1980 and earlier	1	6	-	-	1	3
1981-1985	-	-	1	6	1	3
1986-1990	2	12	4	22	5	17
1991-1995	6	35	6	33	11	34
Total	17	100	18	100	35	100

There were three changes reported by 22 respondents for the crop component (Table 47), the most popular of which was more crop

diversification (50%). About 36% reported that they have stopped growing certain crops, while 14% reported to have cleaned the area and planted more crops with trees. If these responses were further condensed, however, the major change (64%) that has occurred was simply greater crop diversification in the parcela. Most changes were reported for the last 10 years (66%), while over a quarter of the respondents (28%) reported doing these modifications continuously since they have started.

Table 47. Changes made in the non-tree crop component of the two systems.

Type of change	Solar		Parcela		Total	
	No.	%	No.	%	No.	%
Crop diversification	8	47	11	50	19	48
Stopped growing certain crops	2	12	8	36	10	26
Plant trees with crops / clean the area	6	35	3	14	9	23
Applied fertilizer and/or pesticides	1	6	-	-	1	3
Total	17	100	22	100	39	100

Table 48. Year when changes in the non-tree crops were undertaken.

Year	Solar		Parcela		Total	
	No.	%	No.	%	No.	%*
All the time since starting	5	33	5	28	10	30
1980 and earlier	2	13	1	6	3	9
1981-1985	1	7	-	-	1	3
1986-1990	1	7	6	33	7	21
1991-1995	6	40	6	33	12	36
Total	15	100	18	100	33	99

* Total percentage may not equal to 100% because of rounding off errors.

Six changes in the animal component were given (Table 49). The most common change as reported by three persons was that there were more animals added for diversification (43%). One or two respondents reported selling the animals, providing a fence, concentrated raising one animal, and stopped breeding hogs. Only a few (7) respondents provided responses to this portion. Of this number, two respondents did these changes in the last five years.

Table 49. Changes made in the animal component of the two systems.

Type of change	Solar		Parcela		Total	
	No.	%*	No.	%*	No.	%*
Added more animals/ for diversification	10	67	3	43	13	59
Sold animals	2	13	1	14	3	14
Fenced animals	1	7	1	14	2	9
Stopped breeding hogs	-	-	1	14	1	5
Concentrated on one animal	1	7	-	-	1	5
Others	1	7	1	14	2	9
Total	15	101	7	99	22	101

* Total percentage may not equal to 100% because of rounding off errors.

Table 50. Year when changes in the animal component were undertaken.

Year	Solar		Parcela		Total	
	No.	%	No.	%	No.	%*
All the time since starting	6	50	-	-	6	38
1980 and earlier	1	8	-	-	1	6
1981-1985	-	-	1	25	1	6
1986-1990	2	17	1	25	3	19
1991-1995	3	25	2	50	4	25
Total	12	100	4	100	16	94

* Total percentage may not equal to 100% because of rounding off errors.

In general, for all changes in components, the most prevalent was the introduction of more items or more species for greater diversification. This could mean two things in terms of crops and trees: (1) that a greater number of species have been introduced into the system, or (2) more of the same species have been brought into the system. Another important result was that most changes have been made during the last five to 10 years, while other changes have been continuous since the systems were established. The implication is that the systems have been changing (are evolving) through time.

Reasons for the Changes and Sources of Information or Ideas About the Change

Six groups of reasons were gleaned from 18 respondents who provided information as to why they made the changes relating to

the tree component. The most important reason was for posterity or for the future generation (28%), followed by consumption (22%) and because of better production/diversification (22%). The other reasons were: it was an opportunity to plant more trees, the changes were because of problems with previous crops or with water (Table 51).

Table 51. Reasons for changes made in the tree component.

Reason	Solar		Parcela		Total	
	No.	%*	No.	%	No.	%
For consumption	8	38	4	22	12	31
Pass to future generation (for children, family)	4	19	5	28	9	23
Opportunity to plant more trees/fruit trees	6	29	3	17	9	23
Better production/more crops planted	-	-	4	22	4	10
Changes due to problems with previous crops	1	5	2	11	3	8
Water-related problems	2	10	-	-	2	5
Total	21	101	18	100	39	100

* Total percentage may not equal to 100% because of rounding off errors.

The changes in the agronomic crop component were due to four major reasons provided by less than half (14 people) of the respondents (Table 52). These reasons were: better production/ diversification (43%), for consumption (21%), for the future generation (21%), and due to water-related problems (14%).

Table 52. Reasons for changes made in the non-tree crop component.

Reason	Solar		Parcela		Total	
	No.	%	No.	%*	No.	%*
For consumption	12	75	3	21	15	50
Better production/more crops planted	1	6	6	43	7	23
Pass to future generation	1	6	3	21	4	13
Water-related problems	2	13	2	14	4	13
Total	16	100	14	99	30	99

* Total percentage may not equal to 100% because of rounding off errors.

Reasons for changes in the animal component were few and were provided also by a few (6) respondents. The most common reason was because of better production/more livestock raised. The other reasons were: for consumption, for future generations, and a preference for the place by the respondent (Table 53).

Table 53. Reasons for changes made in the animal component.

Reason	Solar		Parcela		Total	
	No.	%*	No.	%*	No.	%*
For consumption	8	67	1	17	9	50
Better production/more livestock raised	2	17	3	50	5	28
Preferences for the place	2	17	-	-	2	11
Pass to future generation	-	-	1	17	1	6
Water-related problems	-	-	1	17	1	6
Totals	12	101	6	101	18	101

* Total percentage may not equal to 100% because of rounding off errors.

From these reasons, there were a few that were common to all components: better production, for consumption, for their children or future generation, and water-related problems. This information has several implications. First, it indicates that one force pushing for these changes was to take advantage of better resources to produce more. It also suggests that part of the produce from the system was at least for consumption. The third implication was that the farmers were future-oriented with respect to their systems by thinking of passing the practice or the benefits to their children.

With regards to source of the idea or information relating to the changes made in all components, a high percentage of respondents indicated a reliance on their own personal experience or knowledge as a major source (Tables 54-56). This percentage was 73% with respect to changes in trees, 80% with respect to crops, and 100% with respect to animals. The other sources were family and friends, fellow farmers, and the government. The number of respondents providing this information was 15 for the trees, 10 for the crops, and one for the animals. These numbers, however, are kind of low.

Table 54. Sources of the idea or information regarding the changes undertaken in the tree component.

Source	Solar		Parcela		Total	
	No.	%	No.	%	No.	%*
Personal experience and/or knowledge /necessity	11	79	11	73	22	76
Family / friends	3	21	2	13	5	17
Fellow farmers	-	-	1	7	1	4
Government	-	-	1	7	1	4
Total	14	100	15	100	29	101

* Total percentage may not equal to 100% because of rounding off errors.

Table 55. Sources of the idea or information regarding the changes undertaken in the non-tree crop component.

Source	Solar		Parcela		Total	
	No.	%	No.	%	No.	%*
Personal experience/ knowledge / necessity	12	100	8	80	20	91
Fellow farmers	-	-	1	10	1	5
Government	-	-	1	10	1	5
Total	12	100	10	100	22	101

* Total percentage may not equal to 100% because of rounding off errors.

Table 56. Sources of the idea or information regarding the changes undertaken in the animal component.

Source	Solar		Parcela		Total	
	No.	%	No.	%	No.	%
Personal experience/ knowledge	3	75	1	100	4	80
Government	1	25	-	-	1	20
Total	4	100	1	100	5	100

Use of Additional Resources

Questions were asked of all respondents whether or not they have used additional resources to effect the changes that they have made and, if they did, where they got the resources. Instead of grouping by system, results are presented here by components because of the low rate of response. This information will help indicate the resourcefulness of the respondents in terms of using other inputs for their systems and the sources of these resources. Results presented here were pooled from all 64 respondents (total for solar and parcela) and are shown in Tables 57 and 58.

The percentage of all respondents (n=64) using additional resources to effect the changes that were made was highest for trees and lowest for the animals. These numbers were 30% for those who made changes relating to the tree component, 22% for those relating to non-tree crops, and 16% for those relating to animals. These results only suggest that, in comparison to the other components, establishing the trees perhaps needed more additional inputs than what the farmer normally had or inputs that were not foreseen earlier as necessary.

Table 57. Use/non-use of additional resources to effect the changes made. *

Component	Yes	%	No	%
Trees	19	30	18	28
Non - tree crops	14	22	11	17
Animals	10	16	1	2

* Based on all respondents from the two systems, hence percentage is based on N=64.

When asked where they got the additional resources, majority of the respondents mentioned that they themselves came up with these additional inputs. This situation was true for all three components (trees, non-trees, and animals). The frequency was highest for the trees and lowest for the animal component, as far as this source (self) was concerned. There were three other sources of the additional inputs: family/relatives for all three components, government was mentioned for the non-tree crops, and others (agriculture professionals) for the trees. These results indicate that not much outside input was actually poured into the system. This situation actually may have helped in keeping intact or more pure the indigenous knowledge or traditional knowledge systems that

relate to the development and management of both the solar and parcela. In short, this situation reflects possible minimization of the influence of information coming from the outside.

Table 58. Sources of additional resources used to effect the changes made.*

Source	Components					
	Trees		Non -tree crops		Animals	
	No.	%	No.	%	No.	%
Self	13	20	10	16	2	3
Other (agricultural prof.)	2	3	-	-	-	-
Relatives / family	2	3	1	2	1	3
Government	-	-	1	2	-	-

* Based on all respondents from the two systems, hence percentage is based on N=64.

C.2. Solares or Home Gardens

Changes Made After the First Year of System Establishment

Only 12% (4 respondents) mentioned that they either increase or decrease the area. However, as in the parcela case, there was no way of telling for sure whether it was an increase or a reduction and on how much that change in the solar area really was. The majority (70%) of the solar respondents did not change the size or area of their solar (Table 43).

Over three-quarters (76%) of the solar respondents have made changes on the system's components after the first year of establishment (Table 44). For changes relating to the tree component (Table 45), three changes were given by a total of 23 respondents. The most common change made, as suggested by 20 people (87%), was that the planting/replanting of more trees or increasing the number of trees (diversification) in their areas. The other two changes were cutting down some trees and cleaning the area, and the use of fertilizer/pesticide in the area. Over one-third of these changes were done during the last five years, while almost half of these changes were made all the time since the system was established. What these results suggest is that most changes were continuously implemented.

With regards to the crops, 17 people provided information

regarding changes made (Table 47). There were four changes given, the most common of which were crop diversification (47%) and cleaning the area and planting more crops with trees (35%). These two alone already account for over 80% of the crop changes. One or two people mentioned the other two changes, namely, that they growing certain crops and that they have used fertilizer and pesticides. Almost half of these changes were made in the last five years, while one-third said these changes were done all the time since the system was established.

For changes in the animal component, there were five modifications provided by 15 members (Table 49). The most important change was that there were now more animals added and thus more diversification (67%). Two people said they sold the animals, while one each responded that they have provided a fence, concentrated raising just one animal, and some other unnamed reason. Fifty percent of those who provided information said that they did these changes continuously, or at any time, since the establishment of their system, while four people (25%) did these changes in the last five years.

Generally, the number one change in all three components was for diversification purposes through the introduction into the area of more items or more species for greater diversification. Fertilizer or pesticide use was also mentioned for the tree and crop components. Most changes have been made either during the last five to 10 years or continuously since the systems were established. Similar to the parcela situation, one implication is that the home gardens also have been changing (or are evolving) through time.

Reasons for the Changes and Sources of Information or Ideas About the Change

There were five reasons given by 21 respondents as to why they made the changes on their tree component (Table 51). The two top reasons were for consumption (38%) and because it was an opportunity to plant more fruit trees (29%). Four people (19%) said it was for their children. The other two reasons were because of problems relating to either the water (9%) or the previous crops (5%).

With regards to the agronomic crops, four reasons were also given by 16 interviewees. The single most common reason was for consumption (75%). The other three reasons were provided by one or two members and are as follows: because of water-related

problems, for future generation, and because of better production/ diversification (Table 52).

Twelve respondents provided a total of four reasons for changes made with regards to the animal component. The most common reason was for consumption (66%). The other two reasons were better production/more livestock raised and the farmer's preference for the place (Table 53).

The number one reason for all three components is the same -- for consumption. Based on these results, it is possible that a large part of the fruits/food produced from the solar sites are for home consumption. Also, while the children play an important reason in relation to changes made in trees, better production is important with regards to changes that were made with respect to the crop and animal components of the solar.

With regards to source of the idea or information relating to the changes made in all components, the information from the solar respondents is quite similar to that from the parcela respondents (Tables 54-56). For instance, a high percentage (75% to100%) of respondents indicated a reliance on their own personal experience or knowledge as a major source. However, this percentage was highest (100%) with respect to changes in non-tree crops, 79% for the trees, and 75% with respect to animals. Likewise, the other sources were family and friends, fellow farmers, and the government. The number of respondents providing this information was also somewhat similar: 14 for the trees, 12 for the crops, and four for the animals.

Use of Additional Resources

The information for this section was pooled for all 64 respondents (33 for solar and 31 for parcela). The results and analysis have been presented under " C.2. Parcelas or Ranchitos."

C.3. Solares Vs. Parcelas

Changes Made After the First Year of System Establishment

With regards to changes in the size of the area, there was a much higher percentage of solar respondents (70%) who indicated that they did not change this variable as compared to parcela respondents (39%). The implication is that the solar sites more or less

stayed the same, as compared to the parcela sites, area-wise. In terms of changes in the components of the system, the majority in both groups of respondents have made such changes. Although chi-square tests indicated no significant difference between the two groups at 0.05 level, the percentage, however, is little higher for the parcela (87%) compared to the solar (76%) respondents. A possible correlation is that the changes in the size or area (higher for the parcela) could have been because of the changes made in the components of the systems (again, this is higher for the parcela). The most common change was either the introduction of more species into the system or the intensification of the planting strategies within the system. Another implication here is that there was not much variation in the changes (evolution) of the solar system as compared to the parcelas in the area.

As to tree-related changes, the number one change in both systems is the same: for greater diversification through planting/ replanting more trees in the area. There were two other common changes but which were way below the number one change -- cleaning and cutting down some trees, and the use of pesticides or fertilizer. There were more changes in the parcela with six as compared to three for the solar. This may not be surprising in the sense that there were more tree species in the former, as discussed in the establishment phase. In both systems, most of the changes were implemented either continuously after establishment of the system or during the last 5-10 years.

For crop-related changes, the number one change in both systems was crop diversification. Other common changes were cleaning and planting the area with trees and more crops, and stopping the planting of certain crops. Similar to the tree-related changes, most of the changes in this component were done either continuously after starting the system or during the last 5-10 years. Parcela respondents gave three changes while solar respondents provided four. There were fewer changes made in this component as compared to changes made with the tree component, indicating that perhaps there may be a limited number of preferred crops that farmers want to use while they sort of do some "experiments" with the trees.

With respect to animal-related changes, parcela respondents gave six changes while solar respondents provided five. This may be interesting since there were a few more respondents who mentioned

animals on their solar compared to the parcelas. However, there were twice as many solar as there were parcela respondents providing this information. Again, the number one change (diversification) was common to both systems. Other common changes were: selling the animals and concentration on raising one animal species only. Most respondents did these changes continuously (any time) after the establishment of their systems.

For both systems and for all changes in all components, the most prevalent was the introduction of more items or more species for greater diversification. The use of pesticides and fertilizer for both the tree and crop components was also interesting. Most changes in these systems were done continuously after the start of the system, and also during the last five years. These results indicate that both systems are continually changing especially in terms of its component species (species mix).

Reasons for the Changes and Sources of Information or Ideas About the Change

The two groups gave more or less the same reasons and number, except that the order (in terms of being commonly mentioned) was different. This order may be taken as an indication of how "common" or "popular" the idea is to the farmers surveyed. The future generation was number one for parcela respondents, consumption and diversification were second. For solar respondents, consumption was number one and the opportunity to plant more trees was second. The other reasons were similarly ranked low for both systems (problems related to water and the previous crops). The only difference was that solar respondents did not mention greater diversification as a reason for the changes they have made with regards to the trees. That consumption was highly ranked is not surprising, because a lot of these trees are fruit trees.

With regards to agronomic crops, both groups mentioned the same four reasons for the change, with about the same number of respondents. Again, the order of "popularity" differed. Better production was number one for parcela while consumption was the single leader for the solar respondents. Consumption and the idea of passing the area off to the next generation were also mentioned by several parcela respondents, whereas the other three reasons were mentioned only by one or two solar respondents. These results suggest that solar production could be largely for family consumption, while parcela outputs could be for both additional income

generation and also for consumption.

For changes in the animal components were more or less the same for the two group but only in different order. Similar to crop changes, consumption was number one for solar but second for parcela. Some members of both groups mentioned that they also preferred the place for raising livestock or animals, and that there were better production opportunities in the area.

Based on the sets of reasons given for the changes made in both systems, there are similarities and differences in both systems. It was clear for instance that, for all components, consumption was more commonly mentioned among solar than parcela respondents, suggesting that production from the solar could be largely for family use or consumption. Both groups looked forward to developing what they have for their children and their future, and this was commonly associated with trees in both groups. Lastly, recognition of better production opportunities was mentioned in relation to changes in crops and trees by both groups.

With respect to their sources of information regarding the changes that were made, personal knowledge or experience was the source most commonly mentioned by both groups of respondents, ranging from 73% to 100% for all three components. Likewise, the other sources but which were not commonly mentioned were the same for both groups. These included the government, family and friends, and fellow farmers. This information strongly suggests that respondents practice mostly traditional technologies, and that they rely mostly on themselves for innovations or modifications implemented in their systems.

Use of Additional Resources

Because of the pooling of responses for all 64 respondents, no comparison could be made for this section. Instead, highlights of the analysis are presented here. For instance, there were more respondents who reported as having used additional resources for effecting the tree component in their system. There were very few who said they did for implementing changes related to the animal component. The implication is that perhaps tree establishment could have required more inputs than what the farmer was prepared to use or what the farmer possessed then.

Most of the respondents mentioned that they themselves

provided the additional input requirements for making the changes in all three components of their system. Three other sources were mentioned -- family and relatives, government, and agricultural professionals. Because the low percentages reported for these other three sources suggest less outside influence on the farmer's self-knowledge, the results imply that the situation perphaps helped promote the purity of the technology and knowledge relating to the development and management of both the solar and the parcela systems in this portion of Mexico.

D. Current Phase

This section presents information regarding the present situation in the area. Included in this section are information on the area under current cultivation, the species that are presently in the area (in 1995), and a ranking of the most important species in each component of the system by the respondents.

D.1. Parcelas or Ranchitos

Area Presently Under Cultivation

The average size of the parcelas surveyed was 5.56 hectares. Almost half (45%) of the respondents have from 1 to 5 hectares of land under cultivation. About one-third had areas one hectare or less but no one had less than a quarter of a hectare. About one-fourth have parcelas that are 5 to 40 hectares in size. The distribution of parcela sizes is shown on Table 59. These sizes ranged from almost a third of a hectare to 40 hectares (Table 60).

Table 59. Total area of the land parcel at present, in hectares.

Area (in hectares)	Solar		Parcela		Total	
	No.	%	No.	%	No.	%
0.02 - 0.25	26	79	-	-	26	41
0.26 - 1.00	3	9	10	32	13	20
1.01 - 5.00	4	12	14	45	18	28
5.01 - 40.00	-	-	7	23	7	11
Total	33	100	31	100	64	100

Table 60. Ranges of the areas for the two systems, at present time.

	Solar	Parcela	Total
Ave area	0.36	5.56	2.88
Range	0.02 - 2.00	0.32 - 40.00	0.02 - 40.00
N	33	31	64

Species Found/Included in the System At Present

There was a quite large number (44) of tree species reported by parcela respondents (Table 61). Of this number, there were 26 species used for food/fruit production primarily, nine species for wood, three species for forage, and six other miscellaneous species. The most common food/fruit species were oranges, lemon, mango, coconut, ciruelas, nance, mamey, and mandarin. The top 15 species here were also mentioned in the earlier part of this report relating to trees that were planted during the establishment phase. The nine species planted for timber included caoba (mahogany), siricote, roble, and pich. Ten other species were for forage and other miscellaneous species.

Table 61 also shows the number and percentage of respondents who reported having these species on their parcelas. For instance, of the 31 respondents, 26 people (84% of the sample) reported having sweet orange in their parcela at present time. For scientific names and the classification (i.e., for wood, food/fruit, forage, other) of these trees, please see Appendix 4.

For the non-tree crops, the top 15 species at present were similar to those that were given by respondents as planted during

the establishment phase (Table 62). The top dozen species included pepper, bananas, corn, chaya, squash, pineapple, frijol, watermelon, jicama, camote, papaya, and pepino. The only difference is that there are now more respondents reporting these species as being present in their parcelas. For instance, there are 21 people now reporting as having banana in the parcela compared to five people who mentioned having them at the time of establishment. Also there are 21 species reported at present phase compared to 19 species reported during the establishment phase.

With regards to the animal species that are found in the parcelas at present, there were nine different types reported for the present compared to the four species mentioned during establishment. Also, there were more citations (total of 23) of having them at present time compared to only seven respondents during establishment. In addition to chickens, hogs, sheep, and bees, there were horses, turkeys, ducks, cattle, and goats that have been reported as being part of the parcelas at present time. Table 63 shows the number of respondents reporting on each of these animal species in their system at present time (at the time they were interviewed).

Table 61. Tree species that respondents presently have on their system.

Tree-species	Solar		Parcela		Total	
	No.	%*	No.	%*	No.	%
Sweet Orange	27	82	26	84	53	83
Lemon	24	73	25	81	49	77
Mango	22	67	24	77	46	72
Coconut	18	54	23	74	41	64
Avocado	18	55	21	68	39	61
Ciruela	22	67	18	58	40	61
Nance	17	51	20	65	37	58
Orange	21	64	16	52	37	58
Mandarin	15	45	20	65	35	55
Guayaba	16	48	13	42	29	45
Mamey	10	30	19	61	29	45
Guanabana	11	33	16	52	27	42
Anona	12	36	14	45	26	41
Guaya	14	42	11	35	25	39
Zapote	12	36	13	42	25	39
Caimitillo	9	27	14	45	23	36
Achiote	8	24	13	42	21	33
Tamarind	12	36	7	23	19	30
Toronja	7	21	11	35	18	28
Ramon	10	30	8	26	18	28
Guano	4	12	12	39	16	25
Caoba	4	12	11	35	15	23
Pimienta	8	24	5	16	13	20
Saramuyo	6	18	5	16	11	17
Jicaro	8	24	2	6	10	16
Limonaria	8	24	2	6	10	16
Siricote	5	15	4	13	9	14
Almendro	5	9	3	10	8	13
Grosella	5	15	3	10	8	13
Chaca	2	6	5	16	7	11
Coyol	3	9	4	13	7	11
Garnada	6	18	1	3	7	11
Roble	3	9	4	13	7	11
Jabin	3	9	3	10	6	9
Maranon	2	6	3	10	5	8
Pich	3	9	2	6	5	8
Chaca Blanco	1	3	3	10	4	6
Corozo	1	3	3	10	4	6
Negrito	1	3	2	6	3	5
Sacpa	2	6	1	3	3	5
Balche	-	-	2	6	2	3
Chacte	-	-	2	6	2	3
Mamoncillo	2	6	-	-	2	3
Granadillo	-	-	2	6	2	3
Guacimo	-	-	2	6	2	3
Zapote negro	1	3	-	-	1	2

* Percentage is based on the total number of respondents per group. For instance, 27 of 33 solar respondents (or 82%) reported having sweet orange in their solar at present.

Table 62. Non-tree crop species that respondents presently have in their system.*

Non-tree crops	Solar		Parcela		Total	
	No.	%**	No.	%**	No.	%
Banana	15	45	21	68	36	56
Pepper	14	12	12	39	26	41
Chaya	7	21	11	35	18	28
Corn	4	12	13	42	17	27
Squash	2	6	14	45	16	25
Pineapple	2	6	11	35	13	20
Frijol	4	12	8	26	12	19
Papaya	4	12	7	23	11	18
Watermelon	1	3	9	29	10	16
Rabano	5	15	2	6	7	11
Sweet Potato	1	3	5	16	6	9
Jicama	-	-	6	19	6	9
Pepino	1	3	5	16	6	9
Cebolla	1	3	3	10	4	6
Cilantro	3	9	1	3	4	6
Napoles	2	6	2	6	4	6
Sugarcane	1	3	2	6	3	5
Tomato	1	3	2	6	3	5
Yuca	1	3	2	6	3	5
Chayote	2	6	-	-	2	3
Cacahuate	-	-	1	3	1	2
Garlic (ajo)	-	-	1	3	1	2

* Based on the total number of respondents providing the information.
** Percentage is based on the total number of respondents per group.

Table 63. Animal species that respondents presently have on their system.*

Animal species	Solar		Parcela		Total	
	No.	%**	No.	%**	No.	%
Chicken	24	73	5	16	29	45
PigHog	15	45	1	3	15	25
Turkey	13	36	2	6	15	23
Bee/beehive	-	-	5	16	5	8
Sheep	2	6	3	10	5	8
Duck	3	9	1	3	4	6
Horse	-	-	4	13	4	6
Cattle (for beef and milk)	2	6	1	3	3	5
Goat	-	-	1	3	1	2

* Based on the total number of respondents providing the information.
** Percentage is based on the total number of respondents per group.

Average Number of Species of Each Component at Present

The average numbers found of each species on the parcelas are shown in Tables 64 and 65, of trees and animal, respectively. For the trees, considering both the number of respondents reporting and the average for the species, it seems that the more prominent fruit tree species are the following: naranja dulce (sweet orange), naranja agria, lemon, coconuts, ciruela, avocado, achiote, nance, mandarina, mango, guanabana, and zapote. The more popular timber trees were mahogany, cedar, and guano (Table 64).

For the animal species (Table 65), based on the number of respondents providing information on units, high averages were mentioned for chickens (five respondents have an average of 26 chickens), three people have an average of 28 heads of sheep, four people have an average of 10 "boxes" of bee production units, and three respondents reported having an average of about five horses. For the other animals, only one or two respondents mentioned as having them in the parcela.

Table 64. Average number of trees presently in the system.

Tree-species	Solar		Parcela		t-test
	N*	Ave.	N*	Ave.	
Achiote	6	13.0	11	67.0	ns
Avocado	16	2.6	18	14.2	**
Anona	11	5.7	13	5.2	ns
Caimitillo	9	2.4	12	3.3	ns
Ciruela	19	3.8	15	5.7	ns
Coconut	16	4.3	20	43.3	**
Coyol	2	1.5	4	3.3	**
Corozo	-	-	3	30.0	--
Garnada	5	1.8	1	4.0	**
Grosella	3	1.0	3	4.7	ns
Guanabana	10	3.0	14	14.5	**
Guaya	12	1.8	9	7.0	ns
Guayaba	15	2.7	12	3.3	ns
Limon	22	2.0	20	62.6	ns
Mamey	10	1.5	16	6.0	**
Mandarin	15	1.7	16	35.8	ns
Mango	19	2.1	19	18.2	**
Maranon	1	1.0	3	2.0	**
Nance	15	3.3	17	8.0	ns

Table 64 continued next page...

Table 64. . . . Continued.

Tree-species	Solar		Parcela		t-test
	N*	Ave.	N*	Ave.	
Orange	19	3.1	15	80.1	ns
Sweet Orange	24	7.9	21	159.8	**
Pimienta	7	2.7	2	3.8	ns
Saramuyo	5	2.4	5	5.4	ns
Tamarind	10	1.6	7	3.1	ns
Toronja	6	2.3	9	4.4	ns
Zapote	11	1.6	10	5.6	**
Balche	-	-	2	13	---
Caoba	2	1.5	9	37.9	**
Cedro	5	2.8	9	114.3	ns
Chacte	-	-	2	27.5	---
Chemchem	-	-	1	25.0	---
Granadillo	-	-	2	10.0	---
Negrito	-	-	2	10.0	---
Pich	2	1.0	2	16.5	**
Roble	2	1.0	4	2.8	**
Chaca Blanco	1	3.0	2	17.0	**
Siricote	2	1.0	4	9.5	**
Tzalam	-	-	1	30.0	---
Cocoite	-	-	1	10.0	---
Chaca	1	1.0	4	10.5	**
Guacimo	-	-	2	6.5	---
Ramon	8	4.8	6	21.0	ns
Almendro	3	1.7	3	1.3	ns
Guano	3	8.3	10	46.7	ns
Guarumo	-	-	1	5.0	---
Jabin	2	1.5	2	60.0	**
Jicaro	5	7.4	1	2.0	**
Limonaria	7	4.0	2	4.5	**
Tronador	-	-	1	5.0	---
Yaiti	-	-	1	30.0	---
Yaxnic	-	-	1	20.0	---
Bojon	1	10.0	-	-	---
Mamoncillo	2	2.0	-	-	---

* N refers to the total number of respondents providing the information.
** Significant difference in averages at 0.05 level.
ns No significant difference in averages at 0.05 level.

Table 65. Average number of animals presently in the system.

Animals	Solar		Parcela		t-test
	N*	Ave.	N*	Ave.	
Chicken	22	28.4	5	25.6	ns
Sheep	2	24.5	3	28.0	**
Turkey	12	16.0	2	2.0	**
Cattle	2	16.0	1	1.0	**
Goat	-	-	1	12.0	---
Bee/beehive	-	-	4	10.3	---
Pig/Hog	15	7.6	1	1.0	**
Duck	3	4.7	1	3.0	**
Horse	-	-	3	4.7	---
Mule	-	-	1	1.0	---

* N refers to the total number of respondents providing the information.
** Significant difference in averages at 0.05 level.
ns No significant difference in averages at 0.05 level.

Most Important Species in Each Component at Present and Why They Are Important

Respondents were asked questions about species in their system that were most important to them and why these species were important. Tables 66 to 68 present the information about these species and the reasons behind their being important to the farmer. Table 66 shows the general listing of all species regardless of whether these were trees, crops, or animals. This information, based on how frequent these were mentioned by respondents, gives an overall picture of the system's elements and what respondents consider as more important regardless of classification. Table 67 categorizes these elements into the three component parts and then the top five were selected and presented. Finally, Table 68 presents the reasons why the species mentioned in the two previous tables were considered important.

Based on all species in the system (Table 66), the top eight items for parcela respondents are as follows: naranja (orange), mango, mandarin, bananas, naranja dulce, mamey, coconut, and pineapple. From these results, it is obvious that fruit trees occupy higher positions in the list. This does not mean, however, that these are the only important species because the other agronomic crops were also mentioned by the respondents in this list. Pineapple was the only non-tree species in the top eight species.

Table 66. List of the most important species as cited by respondents.*

Species	Solar	Parcela	Total
	Freq.	Freq.	Freq.
All species are equally important **	9	3	12
Orange	14	19	33
Mango	5	11	16
Chicken	14	-	14
Banana	5	6	11
Hog/pig	9	1	10
Mandarin	2	7	9
Sweet Orange	3	4	7
Lemon	4	2	6
Mamey	1	4	5
Coconut	2	3	5
Avocado	3	2	5
Guanabana	2	2	4
Pepper	2	2	4
Sheep	2	2	4
Corn	1	2	3
Pineapple	-	3	3
Achiote	-	2	2
Cedar	1	1	2
Turkey	2	-	2
Guaya	2	-	2
Nance	-	1	1
Tangerine	-	1	1
Chevor	-	1	1
Cattle	-	1	1
Caoba	-	1	1
Anona	1	-	1
Zapote	1	-	1
Duck	1	-	1
Jicara	1	-	1
Toronja	1	-	1
Tomato	1	-	1

* Based on frequency of mention of these species. Thus, N would reflect how many times the species has been mentioned. Two to three respondants gave five species, while the rest only mentioned one to three species.

** A general statement given by respondents who did not mention specific tree or non-tree or animal species as asked.

When categorized (Table 67), the same listings per component are very similar to the species that have been brought into the system when it was first established. For trees, they were all for fruit or food production. The non-tree crops are representative of the common crops in the area, while the animals are similar to those

already mentioned in the intermediate phase of the system. In short, there is no difference in the ordering of these species based on information from the establishment and intermediate phases of the system.

The reasons given for these species included ease in selling the outputs, no need to water during dry/drought season, output is for consumption, can be given as gifts, because all other crops grow slowly, for personal satisfaction, and because they (animals) require less food and hay is available anytime. The top reasons were that the outputs could be sold and that no watering is needed in the dry season (Table 68).

Table 67. Five most important species, by component.*

Species, by component	Solar	Parcela	Total
	Freq.	Freq.	Freq.
All species are important**	9	3	12
Trees			
Orange	14	19	33
Mango	5	11	16
Mandarin	2	7	9
Sweet Orange	3	4	7
Lemon	4	2	6
Non-tree crops			
Banana	5	6	11
Pepper	2	2	4
Corn	1	2	3
Pineapple	-	3	3
Tomato	1	-	1
Animals			
Chicken	14	-	14
Hog/pig	9	1	10
Sheep	2	2	4
Turkey	2	-	2
Cattle	-	1	1

* These represent only partial listings, showing the top five species in each category or component.

** A general statement given by respondents who did not mention specific species as asked.

Table 68. Reasons for importance of selected important species (trees, non-tree crops, and animals).*

Reason	Solar	Parcela	Total
	Freq.	Freq.	Freq.
For sale (can be sold anytime)	3	24	27
For food and also for sale	15	5	20
Do not need to be watered during the dry season or drought	8	10	18
Can be given as gift	1	3	4
Everything is equally important	4	-	4
All the other crops grow slowly	-	3	3
For personal satisfaction	1	1	2
Require less food and hay is available anytime	-	1	1
Can be processed as drinks	1	-	1
For shade	1	-	1
For food and shade	1	-	1

* Based on frequency of mention of these reasons. Thus, N would reflect how many times the reasons has been mentioned. Two to three respondants cited five reasons, while the rest only mentioned one to three reasons.

D.2. Solares or Home Gardens

Area Presently Under Cultivation

The average size of the solar surveyed was 0.36 hectare. The solar size is generally small, with about 88% of the respondents reporting one hectare or less. Only 12% of the respondents have home gardens from 1-5 hectares, and 5-hectare home gardens are exceptions rather than the rule in the areas surveyed. For the whole group, the solar areas ranged from 0.02 to 5.0 hectares in size. The distribution average and range of solar sizes are shown on Tables 59 and 60.

Species Found/Included in the System At Present

There was also a high number (42) of tree species reported by solar respondents (Table 61). Of this number, there were 27 species used for food/fruit production primarily, six species for wood, two for forage, and seven other species. The most common food/fruit species were similar to those found in the parcela: oranges, lemon, mango, coconut, ciruelas, nance, mamey, and mandarin. These top species here were similar to those mentioned in the establishment phase of the solar. The six timber species included caoba, siricote,

roble, pich, negrito, and chaca blanco. There were two forage species and seven miscellaneous species.

Table 61 shows the number and percentage of respondents who reported having these species on their solar. For instance, of the 33 respondents, 27 people (82% of the sample) reported having sweet orange in their solar at present time. For scientific names and the classification (i.e., for wood, food/fruit, forage, other) of these trees, please see Appendix 4.

There are more non-tree crops species (19) reported at present compared to the 12 species reported during the establishment phase (Table 62). The top 10-15 species at present are more or less similar to those that were reported during the establishment phase. The only difference is that, similar to the parcela case, there are now more respondents reporting these species as being present in their solar. For instance, for bananas again, there are 15 people now as compared to only two people during establishment who reported as having bananas in their solar.

There are now six types of animals in the solar compared to the five species when farmers were just establishing these systems (Table 63). Also, there are a lot more respondents reporting that they have animals on their solar sites. For instance, there were twice as many respondents now (24 people) saying that they have chickens in their solar compared to only 10 respondents reporting the same during the establishment phase. The most common animals found in the solar are chickens, hogs, and turkeys. The new or additional species in the solar was cattle for beef and/or milk.

Average Number of Species of Each Component at Present

For the solar, the average numbers found of each species are shown in Tables 64 and 65 for the tree and animal species, respectively. Considering both the number of respondents reporting and the average for the tree species, the more prominent fruit tree species planted in the solar include the following: naranja dulce (sweet orange), naranja agria, coconuts, anona, achiote, nance, mango, lemon, ciruela, avocado, and caimitillo. The more popular timber tree species was cedar, for forage was ramon, while guano and limonaria were the more predominant miscellaneous species.

For the solar and based on the number of respondents providing information on units, high averages were mentioned for a

number of animals. For example, 67% of the solar respondents reported having chickens and the average was over 28 units of these fowls. On the average, 12 respondents have reported 16 turkeys each, 15 people have about 8 pigs each, two people have 16 heads of cattle each, and three respondents reported having about 5 ducks, on the average. Comparatively, there are higher averages for the animals in the solar than in the parcela.

Most Important Species in Each Component at Present and Why They Are Important

Tables 66 to 68 present the information about important species and the reasons why they are important to the respondents. Table 66 shows the general listing of all species regardless of whether these were trees, crops, or animals. Table 67 presents the top five species for each component. Table 68 presents the reasons why the species mentioned were considered important.

For solar respondents, the top eight items from the general list are: naranja (orange), chickens, hogs, mango, bananas, lemon, naranja dulce, and avocado. This list contains both fruit trees and animals. As in the case for parcela, agronomic crops also made it to the list, although not as frequent as these top eight species (Table 66).

When categorized, the top five listings per component are similar to the species brought into the system when it was first established. For instance, the trees were all for fruit production. The non-tree crops are representative species in the area and the animals are also common in the area. The situation is very similar to that for the parcela (Table 67).

There were nine reasons given why these species were important (as compared to the seven from parcela respondents). These reasons included producing for consumption, no need to water during dry/drought season, ease in selling the outputs, everything is important, can be given as gifts, for personal satisfaction, can be processed as drinks, for shade, and food and shade. The top two reasons were for consumption and that no need to water in the dry season (Table 68).

D.3. Solares Vs. Parcelas

Area Presently Under Cultivation

A solar is generally much smaller than a parcela. The average solar area was 0.36 hectare compared to the average parcela area of 5.56 hectares. The majority (88%) of solar respondents have one hectare or less in area while more than two-thirds (68%) of parcela respondents have one hectare or more in terms of area. Moreover, the largest reported solar was 5 hectares, which was an exception, while that for the parcela was about 40 hectares (Table 59 and 60).

Species Found/Included in the System At Present

There was about the same total number of tree species reported in each system (Table 61). There was also about the same number and same tree species planted for food/fruits and other miscellaneous species, but there were more timber or forest species in the parcela (9 species) than the solar (6). There were more people reporting as having these species in their systems (solar or parcela) now as compared to the establishment phase.

For the non-tree crops (Table 62), the top 15 species were more or less similar in both systems. Another similarity between the two systems is that these species were more or less the same compared to the ones that were planted during the establishment phase. A third similarity is that, in both systems, there are more people at present who report as having these species in their areas now compared to the number who reported during the establishment phase. The only difference is that, for solar, there are more species reported at the present phase than at the establishment phase.

With regards to the animal species (Table 63), the number of animal types was lower in the solar (6) compared to the parcela (10). Another difference was that, comparing the establishment and present phases, there were more than twice as many animal species reported in the parcela (from 4 to 9 types) than in the solar (from 5 to 6 types). What these results imply is that there is simply more variation in livestock raised in the parcela than in the solar. It does not mean, however, that there were actually more animals in the parcela than in the solar. This question will be answered with the information on the average numbers of each species that are found in each system, as discussed next.

Average Number of Species of Each Component at Present

With regards to the average numbers for the tree and animal components in these systems, the number of respondents reporting and the calculated averages were considered in comparing the information for both systems. A t-test was also done to determine if these average numbers by species were significantly different or not in both systems. This was done in order to give a better picture of which species are more likely to be found in greater numbers in which system.

For the tree species (Table 64), and considering the number of respondents reporting and the average number calculated of each species, the popular fruit trees were more or less the same for both systems: naranja dulce (sweet orange), naranja agria, lemon, coconuts, ciruela, avocado, mandarina, mango, nance, achiote, anona, guanabana, caimitillo, and zapote. In terms of timber tree species, cedar was popular in both systems while caoba was predominant in the parcela only (or significantly different at 0.01 level). For forage species, ramon was common to both systems.

When information on the average number of animals found in both systems was compared, there were higher averages reported for all animals in the solar than in the parcela with the exception of sheep (Table 65). Thus, there were more chickens, turkeys, cattle, ducks and others on the solar. This was based on the number of respondents who provided information on units of animals they have on the system. Considering that the solar is closer to home than the parcela, and with problems of animals being stolen, it is not surprising to know that there were also more solar respondents reporting they have these animals on the solar. Besides, some respondents have indicated having placed fences for the animals. However, the parcelas have more variety with regards to the animal component of the system, i.e., there were more species reported for the parcela (10) than for the solar (6).

The t-test conducted on the differences of these averages in the two systems are also shown on Tables 64 and 65. For the tree component, there are significant differences in the averages of some species in these systems. For instance, such difference is significant at the 0.01 level for such species as naranja dulce, mamey, caoba, mango, granada, coyol, and some of the timber species. These means that there are more trees, on the average, that are planted of these species in a parcela compared to a solar, or more in a solar compared

to a parcela. For the animals, this difference is significant at the 0.01 level for sheep, turkey, cattle, hogs, and ducks. For the chickens, it is not significant, meaning there are about the same average number of chickens in both systems. For the non-tree crops, no t-tests were done, since there was no information on averages provided.

Most Important Species in Each Component at Present and Why They are Important

Comparing the top eight species list from the general list of species (Table 66), the parcela listing consisted of all trees while the solar listing contained both trees and animals. Probability-wise, this may be expected in the sense that more solar respondents reported having animals in their systems.

In both solar and parcela, the top five species in each category or component were similar to those that were mentioned during the establishment and intermediate phases of the systems (Table 67).

In terms of reasons given as to why the species were important (Table 68), there were more reasons mentioned by solar than by parcela respondents. In addition, based on frequency, while solar respondents mentioned consumption as the number one reason, parcela respondents suggested the ease of selling the output as the top reason. However, the second most-often mentioned reason was the same for both groups, and this is that there is no need to water the species during droughts or the dry season.

VIII. OPERATION AND MANAGEMENT OF AGROFORESTRY SYSTEMS

A. Material Inputs

This section presents the types of material inputs that the respondents used for their trees, crops, and animals. Also included are the annual total costs of these inputs as computed per activity as a whole and the sources of these inputs.

A.1 Parcelas or Ranchitos

Type of Material Inputs Used

The activities where inputs were used mostly evolved around maintaining the three components. For trees, these include weeding, fertilization, and pest control. For the crops, these activities include fertilization and pest control. For the animals, only a handful of respondents cited that they used some inputs to maintain them and these resources were mostly used in feeding, vaccination, and deparasitation activities.

As shown on Table 69, of the 33 respondents, only seven people used herbicides and weedicides. Of the four chemicals used, the most popular is Gramoxan (used by 4 out of 7 who reported). The rest were Gorrixone, Thordon, and mixed herbicides. For fertilization, seven reported using 17-17-17 fertilizer, also known as Triple 17, while the rest used urea and a mixture of fertilizers. The respondents also showed to have some kind of varied choices of pesticides with at least 9 brands being mentioned. Among these the most common ones, as used by two farmers each, are Folidol, Novacron, and Gramoxan. This variation in brands could be surmised as partly due to the presence of different forms of pests in the locality such as white mosquitoes and ants which attack the trees.

For the crops, almost similar brands were used as those used in trees (Table 70). In addition to Triple 17 and urea, the other fertilizers used were Grow Green and 18-18-18. For controlling pests, variation is evident as eight respondents mentioned using 7 different brands with Folidol as the most common one (used by 2 out of 8 persons who reported).

Table 69. Type of material inputs used for the tree component.

Activitiy and type of input	Solar		Parcela		Total	
	No.	%*	No.	%*	No.	%
MAINTENANCE						
1. WEEDING						
Gramoxan	-	-	4	13	4	6
Gorrixone	-	-	1	3	1	2
Thordon	1	3	1	3	2	3
Hierbamino (herbicides in general)	1	3	1	3	2	3
2. FERTILIZATION						
Triple 17 (17-17-17)	6	18	5	16	11	17
Urea	7	21	1	3	8	13
Mixed (17-17-17 & 0-46-0)	-	-	1	3	1	2
3. PEST CONTROL						
Novacron	1	3	2	6	3	5
Gramoxan	-	-	2	6	2	3
Gesapax	1	3	-	-	1	2
By fumigation	1	3	-	-	1	2
Tordan	-	-	1	3	1	2
Gufosato	-	-	1	3	1	2
Monzate	-	-	1	3	1	2
Doblete	-	-	1	3	1	2
Folidol	-	-	2	6	2	3
Melitico Liquido	-	-	1	3	1	2
Venom	-	-	1	3	1	2
Lanate	1	3	-	-	1	2
Puretion	1	3	-	-	1	2

* Percentage is based on the total number of respondents in the sampled groups, i.e. 33 for solar and 31 for parcela.

For maintaining their livestock, the inputs used come in the form of commercial feeds, medicines for vaccination and deparasitation. Except for two persons who reported Vampirol in deworming animals, the rest of deparasitation drugs were used by only one respondent each - Arcil for vaccination and Olmissin, Hierro and Fraje for deparasitation (Table 71). The fact that very few used these types of inputs for animal care implies less popularity perhaps because of the high costs of these veterinary drugs together with the related services.

Table 70. Type of material inputs used for the non-tree crop component.

Activity and type of input	Solar		Parcela		Total	
	No.	%*	No.	%*	No.	%
MAINTENANCE						
1. FERTILIZATION						
Triple 17 (17-17-17)	2	6	1	3	3	5
Urea	1	3	1	3	2	3
Grow Green	-	-	1	3	1	2
18-18-18	-	-	1	3	1	2
2. PEST CONTROL						
Folidol	-	-	2	6	2	3
Gesapax	1	3	1	3	2	3
Novacron	-	-	1	3	1	2
Gramoxan	-	-	1	3	1	2
Monzate	-	-	1	3	1	2
Venom	-	-	1	3	1	2
Combination **	-	-	1	3	1	2
3. PRUNING						
Monzate	1	3	-	-	1	2
Grow Green	1	3	-	-	1	2
Tameron	1	3	-	-	1	2

* Based on total number of respondents per group, i.e. 33 for solar, 31 for parcela.

** Combination of Thiodan, Malathion, Tanaron, and Monzate

Table 71. Type of material inputs used for the animal component.

Activity and type of input	Solar		Parcela		Total	
	No.	%*	No.	%*	No.	%
FEEDING						
1. CUTTING OF FORAGE						
Corn, grasses & other feeds from farm	14	42	-	-	14	22
Commercial Feeds	-	-	1	3	1	2
2. PASTURE						
Material Pasture	3	9	1	3	4	6
SANITATION						
1. Vaccination						
General vaccines	1	3	1	3	2	3
Cosediases	1	3	-	-	1	2
Ampicillin	1	3	-	-	1	2
Mewceta	1	3	-	-	1	2
Arivil	-	-	1	3	1	2
2. Deparasitation						
Panacor	1	3	-	-	1	2
Ampicillin	1	3	-	-	1	2
Olmissin	1	3	-	-	1	2
Helmicin	-	-	1	3	1	2
Hierro	-	-	1	3	1	2
Vampirol	-	-	2	6	2	3

* Based on total number of respondents per group, i.e. 33 for solar, 31 for parcela.

Average Total Costs of the Material Inputs Used

Mexico's monetary currency is the New Mexican peso (N$). The exchange ratio in July 1995 was about N$6 to one US$. The cost figures reported here are in terms of nominal 1995 N$.

At a glance, the annual average costs range from a low of N$34 for crop pest control to a high of N$470 for weedicides and herbicides (Tables 72 and 73). Computations were based only on data provided by respondents on monetary figures associated with the different inputs they used.

The costs for maintaining the trees do not differ under the three activities for this component. Average total cost for weeding is N$470 followed by fertilizer costs at N$225 and pesticides at N$141. For crops, average total cost for fertilization is N$173 compared to N$34 for pesticides.

While the costs for maintaining the trees and crops range from a less than a hundred to almost half of a thousand N$, average total costs for livestock care are respectively low: N$166 for feeding inputs and N$156 for the deworming drugs. The yearly vaccination cost is also very low at N$150 annually. As there are less animals raised, animal care costs in the parcelas are also expected to be low (Table 74).

Table 72. Average total costs per year of material inputs used for different activities for trees, in nominal 1995 N$.

Activity and Average	Solar	Parcela	t-test
WEEDING			
N*	2	4	
Average	49	470	**
FERTILIZATION			
N*	10	6	
Average	133	225	ns
PEST CONTROL			
N*	1	6	
Average	654	141	**

* N refers to the number of respondents providing the information.
** Significant difference in means at 0.05 level.
ns No significant difference in means at 0.05 level.

Table 73. Average total costs per year of material inputs used for different activities for non-tree crops, in nominal 1995 N$.

Activity and Average	Solar	Parcela	t-test
FERTILIZATION			
N*	2	2	
Average	62	173	**
PEST CONTROL			
N*	-	4	
Average	-	34	--
PRUNING			
N*	1	-	
Average	752	-	--

* N refers to the number of respondents providing the information.
** Significant difference in means at 0.05 level.

Table 74. Average total costs per year of material inputs used for different activities for animals, in nominal 1995 N$.

Activity and Average	Solar	Parcela	t-test
CUTTING OF FORAGE			
N*	12	1	
Average	702	166	**
VACCINATION			
N*	6	1	
Average	266	220	**
DEPARASITATION			
N*	2	3	
Average	2218	156	**

* N refers to the number of respondents providing the information.
** Significant difference in means at 0.05 level.

Sources of the Material Inputs Used

Because of low number of responses per group, discussion of this portion is based on responses of all members of the two groups. Tables 75 to 77 show the responses for this item. Answers indicate various sources of material inputs as shown by many sources with very low frequencies. Exceptions are the sources of fertilizers and pesticides used for trees and the sources of forage and vaccines for animals where four or more persons cited the same source.

Generally, most of the material inputs for all the components are either produced locally or are purchased with external assistance. For direct-purchased items, the ejidatarios went to the towns of

Chetumal (the nearest town) Felipe Carillo, Xul-ba, Alvaro Obregon, and Roviroza. The ingenio (sugar refinery) is also cited by few as the source of some of their fertilizers. Other mentioned sources are the government and from relatives or friends who, probably, were the ones who gifted them with some of their material inputs.

Table 75. Source of material inputs used for the tree component.*

Source	Total No.	Total %**
WEEDING INPUTS		
Produced locally	2	3
Bought with external assistance	1	2
From the sugar refinery (ingenio)	1	2
Chetumal (nearest town)	1	2
Government & produced locally	1	2
FERTILIZERS		
From the sugar refinery (ingenio)	4	6
Chetumal town	2	3
Felipe Carillo town	2	3
Government	2	3
Bought with external assistance	2	3
Produced locally	2	3
Were just given as gift	1	2
Alvaro Obregon town	1	2
PESTICIDES		
Chetumal town	6	9
Bought with external assistance	1	2
Produced locally	2	3

* Solar and parcela respondents combined.
** Total percentage is based on the total number of respondents, i.e. N=64.

Table 76. Source of material inputs used for the non-tree crop component.*

Source	Total No.	Total %**
FERTILIZERS		
Bought with external assistance	3	5
Chetumal town	2	3
Were just given as gift	1	2
From the ingenio	1	2
PESTICIDES		
Produced locally	2	3
Chetumal town	2	3
Bought with external assistance	1	2
PRUNING INPUTS		
Felipe Carillo town	3	5

* Solar and parcela respondents combined.
** Total percentage is based on total number of respondents, i.e. N=64.

Table 77. Source of material inputs used for the animal component.*

Source	Total No.	Total %**
FORAGE (for feeding)		
Produced locally	5	8
Bought with external assistance	5	8
Others	2	3
Xul-ba	2	3
Roviroza	1	2
PASTURE INPUTS		
Chetumal town	4	6
Produced locally	2	3
Bought with external assistance	1	2
From the ingenio	1	2
VACCINATION INPUTS		
Chetumal town	5	8
Bought with external assistance	2	3
Produced locally	2	3
From the ingenio	1	2
DEPARASITATION INPUTS		
Chetumal town	3	5
Government	1	2

* Solar and parcela respondents combined.
** Total percentage is based on total number of respondents, i.e. N=64.

A.2. Solares or Home Gardens

Type of Material Inputs Used

Like those in parcela, material inputs used in the solares also vary. In Table 69, for weeding tree plantation, two persons mentioned using Thordon and hierbamino. For controlling pests, one person each used Novacron, Gesapax, Lanate, and Puretion. Fumigation was also reported as pest control measure by one respondent. Only in fertilizing trees that respondents have two common brands of fertilizer. Seven out of 13 reported using urea and six others used Triple 17.

For crop maintenance, four people reported using Triple 17 and another one mentioned urea. Pest problems in the solares is deduced to be not as serious as in the parcela because only one person reported using a pesticide (Gesapax) in controlling crop pests. For pruning, three people mentioned using Monzate, Grow Green, and Tameron (Table 70).

Generally, animal feeding in the solares must have been a busy activity with14 people reporting cut forage (e.g.. corn and grasses) as input for livestock (Table 71). Preparing material pasture is also indicated by three respondents. As most of the livestock are kept and raised in the solares, more feeding activity is expected here. For sanitation, a wide array of vaccines and dewormers is reported to be used by respondents. These include Cosediases, Ampicillin, Mewceta, general vaccines, Panacor, and Olmissin.

Average Total Costs of the Material Inputs Used

Except for weeding and fertilizing trees, the average total costs for all material inputs in different activities are within the range from N$49 to N$2,200. For maintaining trees, weeding cost is very low at N$49 compared to the pesticide cost at N$654 (Table 72). In between is the fertilizers' average total cost of N$133. It is not surprising to see how small these figures are compared to those in parcela because areas in parcelas are relatively bigger. For crop maintenance, fertilization and pruning costs are nearly similar at N$62 and N$75, respectively (Table 73).

Animal care costs also vary with the exception of vaccination cost which is low and is almost equal to that in the parcela (N$265 against N$220). On the other hand, solar forage cutting/feeding cost is quite high, N$702 compared to N$166 in parcela while deparasitation is high at N$2,218 compared to N$156 in parcela (Table 74).

Sources of the Material Inputs Used

This portion is being discussed together with the parcela respondents. Please refer to sub-section "A.1. Parcelas or Ranchitos".

A.3. Solares Vs. Parcelas

Type of Material Inputs Used

For trees, parcela respondents reported using more inputs relating to maintenance activities than solar respondents. For instance, they mentioned four inputs for weeding (2 inputs were mentioned in solar) and nine inputs for pest control (solar respondents only cited five inputs). These results simply indicate that more types of inputs are used for tree care in parcela compared to the solares. In terms of total number of people responding, there

were 20 for the solar respondents as against 26 for the parcela.

For non-tree crops, the same trend as above is observed. There were 12 input types reported by parcela respondents compared to only six made by solar respondents. However, there were no pruning related inputs reported for the parcela. Again, these results support earlier findings of more non-tree crop species in parcelas than in solares. With regards to total number of people reporting, there was a total of 12 for parcela compared to only seven for the solar.

For animals, there were more inputs (9) and people reporting (24) for the solar group compared to the parcela group (7 input types reported by a total of 8 people). A very common activity was cutting of forage for the solar animals, which was reported by 42% of solar respondents. This was not reported by a single parcela respondent.

Average Total Costs of the Material Inputs Used

In terms of costs, t-tests indicated that average costs were significantly different at 0.05 level for almost all inputs used for the trees, non-tree crops and animals. The only costs that were compared and were not significantly different were for fertilizing the tree component.

The costs higher in the solares were those for pest control (in trees), and all those relating to animals. Animal care is generally very expensive and most higher figures in solar only indicate that there are more animal components in this system.

Sources of the Material Inputs Used

As to sources of material inputs, no meaningful comparison can be made due to very low numbers. Most inputs for the three components are either produced locally or are purchased from town usually with external assistance.

B. Labor Inputs

Presented in this section are results and discussions regarding the labor requirements for both systems. The strategy was to divide the whole management process into three major operations. The various management activities were identified by operation. Respondents were then asked regarding the principal activities associated with the management of trees, crops, and animals.

Information was also obtained regarding family labor that went into the operation and management of the systems. Questions on hired help and the terms and amount of payment were also asked. The information will be presented by system and by topic or variable, as was the pattern for the previous sections.

A comparison of the two systems in terms of the variables discussed under each system is presented last. The discussions here also include the results of t-tests conducted to see if there were significant differences in the average time spent by family members and hired labor in the two systems.

B.1. Parcelas or Ranchitos

Principal Activities and Schedules Associated with System's Components

The management process was divided into three major operations: establishment, maintenance, and production. For each of these operations, specific activities were identified. The various activities under each of these three major operations are as follows:

1. Establishment
   1.1. site selection and preparation
   1.2. planting
2. Maintenance
   2.1. weeding
   2.2. watering
   2.3. fertilization
   2.4. pest control
   2.5. pruning
   2.6. labor for crop cultivation (labor de cultivos)

3. Production
   3.1. harvesting
   3.2. processing
   3.3. sale
   3.4. transportation

For farm activities relating to the animal component, there were four major activities identified. These are as follows:

1. Acquisition of animals
   1.1. breeding
2. Feeding
   2.1. cutting of forage/hay
   2.2. pasture
3. Sanitation
   3.1. deparasitation
4. Sale

Family Labor: Involvement of Members in Various Management Activities

Involvement of various family members in each of the three major operations was investigated. Their participation in the various activities was examined in terms of number of hours spent on these activities. As much as possible, their labor spent on these activities were identified for each of the three components of the system -- trees, crops or non-trees, and animals.

Originally, respondents were specifically asked about the involvement of family members in managing each of the tree, non-tree crop, and animal components of the system. Some respondents found it hard to separate their involvement according to these components. As a result, some respondents provided information about family participation in operations relating to animals, to trees, and to trees and non-tree crops combined. Because it was not possible to separate some information into components, the data are presented as such in Tables 78 to 80.

Table 78 shows who among the family members were involved with various management activities for trees and crops combined. The information was based on those respondents who provided the data. For parcela respondents in the establishment phase, the respondent was chiefly responsible for planting and for site preparation (although none reported on this activity, it was based on

comments made). For the maintenance portion, the principal person is the respondent (if male, a letter M is indicated) but the wife and children usually help. For some activities under maintenance, the respondent does most of the work, such as fertilizer application, pest control, pruning, and crop cultivation. Sometimes, other members help such as the respondent's father or brother. For the production activities, it is again the respondent who is involved in the sale and in transporting to the market. However, the children often help in the harvesting activity.

In general, the respondent is very much involved with most of the activities. There are certain activities that are taken cared of only by the respondent. The only activity where the wife is often involved with is weeding (under maintenance operations). In fact, based on this table, the children help the father more often than the mother does in terms of more activities that children participate in.

Table 78. Family members' involvement in different farm activities relating to tree and non-tree crop production.

Activity and family members involved	Solar		Parcela		Total	
	No.	%*	No.	%*	No.	%
ESTABLISHMENT						
1. Site selection and preparation						
Husband and wife	1	3	-	-	1	2
2. Planting						
Respondent only (M)	1	3	3	10	4	6
Husband & children	1	3	-	-	1	2
Respondent & father	-	-	1	3	1	2
MAINTENANCE						
1.Weeding						
Husband & children	3	9	4	13	7	11
Respondent only (M)	2	6	4	13	6	9
Husband & wife	2	6	3	10	5	8
Whole family	4	12	-	-	4	6
Wife	3	9	-	-	3	5
Children	2	6	1	3	3	5
Respondent & brother	1	3	-	-	1	2
Wife & children	-	-	1	3	1	2
Respondent & father	-	-	1	3	1	2

Table 78 continued next page...

Table 78. . . . Continued.

Activity and family members involved	Solar		Parcela		Total	
	No.	%*	No.	%*	No.	%
2. Watering						
Respondent only (M)	1	3	3	10	4	6
Children	-	-	1	3	1	2
Husband & wife	1	3	-	-	1	2
Husband & children	1	3	-	-	1	2
3. Fertilization						
Respondent only (M)	1	3	2	6	3	5
Wife	1	3	-	-	1	2
4. Pest Control						
Respondent only (M)	-	-	2	6	2	3
5. Pruning						
Respondent only (M)	-	-	1	3	1	2
6. Labor de Cultivos						
Respondent only (M)	-	-	2	6	2	3
Wife	1	3	-	-	1	2
PRODUCTION						
1. Harvesting						
Respondent only (M)	1	3	2	6	3	5
Wife	1	3	-	-	1	2
Whole family	1	3	-	-	1	2
Husband & children	-	-	1	3	1	2
2. Processing						
Husband & children	-	-	1	3	1	2
3. Sale						
Respondent only (M)	-	-	1	3	1	2
4. Transportation						
Respondent only (M)	-	-	1	3	1	2

* Percentage is based on the total number of respondents per group.

Table 79 shows data obtained for management of the tree component only. Based on information from this table, the parcela respondent is again the principal management person. However, in this component, the participation of children and the wife in more activities is noticeable. For instance, the children are involved in planting, weeding, pest control, and pruning. The wife is involved mostly with maintenance activities. Another noticeable thing is that the wife and kids were not mentioned as helping with the harvesting -- and this may be because of the kind of effort required in harvesting (logging) the tree itself.

Table 79. Family members' involvement in different farm activities relating to trees.

Activity and family members involved	Solar		Parcela		Total	
	No.	%*	No.	%*	No.	%
ESTABLISHMENT						
1. Site selection and Preparation						
Husband and wife	1	3	-	-	1	2
Respondent & father	-	-	1	3	1	2
2. Planting						
Respondent & brother	-	-	1	3	1	2
Husband & children	-	-	1	3	1	2
MAINTENANCE						
1.Weeding						
Respondent only (M)	1	3	4	13	5	8
Husband & wife	5	15	-	-	5	8
Husband & children	1	3	3	10	4	6
Whole family	1	3	2	6	3	5
Wife	1	3	-	-	1	2
Children	1	3	-	-	1	2
Respondent & brother	1	3	1	3	1	2
2. Watering						
Husband & wife	-	-	1	3	1	2
3. Fertilization						
Whole family	-	-	1	3	1	2
Respondent only (M)	1	3	-	-	1	2
4. Pest Control						
Whole family	1	3	-	-	1	2
Husband & children	-	-	1	3	1	2
5. Pruning						
Whole family	-	-	1	3	1	2
Respondent only (M)	1	3	-	-	1	2
PRODUCTION						
1. Harvesting						
Respondent & brother	-	-	1	3	1	2

As far as the management of the animal component is concerned (Table 80), the wife and children were mentioned as involved in cutting hay/forage, pasturing the animals, and in sanitation (deparasitation) activities. Only the breeding and the sale activities were reported as done solely by one respondent.

Table 80. Family members' involvement in different farm activities relating to animals.

Activity and family members involved	Solar		Parcela		Total	
	No.	%*	No.	%*	No.	%
ACQUISITION OF ANIMALS						
1. Breeding						
Respondent & father	-	-	1	3	1	2
FEEDING						
1. Cutting of Forage						
Wife	16	48	-	-	16	25
Husband & wife	2	6	1	3	3	5
Respondent only (M)	1	3	1	3	2	3
Mother, sister & brother	1	3	-	-	1	2
Respondent & grandchildren	1	3	-	-	1	2
2. Pasture						
Children	-	-	1	3	1	2
Husband & wife	-	-	1	3	1	2
Whole family	1	3	-	-	1	2
SANITATION						
1. Deparasitation						
Respondent only (M)	2	6	1	3	4	6
Wife & children	-	-	1	3	1	2
SALE						
Respondent only (M)	-	-	2	6	2	3
Wife	1	3	-	-	1	2

* Based on the total number of respondents per group, i.e. 33 for solar and 31 for parcela.

Family Labor: Hours Devoted to Various Management Activities

Tables 81 to 83 present information regarding the hours spent by family members on different management activities relating to the combined tree and non-tree components, the tree component, and the animal component, respectively. As mentioned earlier, the combination was a result of respondents not separating information for the tree and the crop components. These averages reflect the average or mean of the combined efforts of all members of the family, including the respondent, who are involved with the activity.

For the combined tree/crop component, Table 81 shows the average number of hours spent by the family on each activity per year. The N refers to the number of respondents reporting. The data show that family members spent the biggest chunk of time on weeding, the activity with the highest average number of hours (770) per year among all activities. Based on a 40-hour workweek

(8 hours per day, 5 days a week, 52 weeks a year), this average is equivalent to over four months weeding activity for one person working full time, or slightly over a month per member for a family of four. Family members also spent a fair amount of time on watering, planting, and transportation. The low average hours of family labor on such activities as fertilization (87 hours), crop cultivation (89 hours), and harvesting (110 hours) suggest that the family just did not do much in terms of these activities for both trees and crops.

Table 81. Average number of hours (per year) spent by family members in each activity for trees and non-tree crops combined.*

Activity	Solar	Parcela	t-test
ESTABLISHMENT			
1. Planting			
N**	-	4	
Average	-	167	---
MAINTENANCE			
1. Weeding			
N**	15	13	
Average	671	770	ns
2. Watering			
N**	2	3	
Average	235	231	***
3. Fertilization			
N**	1	2	
Average	62	87	***
4. Labor de cultivos			
N**	2	2	
Average	1222	89	***
PRODUCTION			
1. Harvesting			
N**	3	2	
Average	343	110	***
2. Transport			
N**	-	1	
Average	-	156	---

* Average refers to average numbers of hours spent by the family on the activity. Family members include the respondent.

** N refers to the number of respondents providing the information.

*** Significant differences in averages at 0.01 level.

ns No significant difference at 0.05 level.

Table 82 shows the information regarding average time the family spends on activities relating to trees only. There were three activities reported on by very few parcela respondents. Of these three, weeding is where the family spent most time (1,656 hours per year, or over nine months full time work). This suggests several situations such as the following: this activity is an extended practice, there are more members involved, the parcela is quite big, and there are many trees that need tending. Planting the trees, however, did not require much family participation with 96 hours for the year or just about half a month's full time equivalent.

Table 82. Average number of hours (per year) spent by family members in each activity relating to trees only.*

Activity	Solar	Parcela	t-test
ESTABLISHMENT			
1. Site Selection & Preparation			
N**	-	1	
Average	-	200	---
2. Planting			
N**	-	1	
Average	-	96	---
MAINTENANCE			
1. Weeding			
N**	9	6	
Average	208	1656	ns
2. Fertilization			
N**	1	-	
Average	0.5	-	---

* Average refers to average numbers of hours spent by the family on the activity. Family members include the respondent.

** N refers to the number of respondents providing the information.

ns No significant difference at 0.05 level.

On family labor spent on activities relating to the animal component (Table 83), very few respondents provided the information. Noticeable, however, are the high averages reported for pasturing the animals and the cutting of forage for the animals. However, based on a full time equivalent (2,080 hours per year) for a person, the 3,741 hours per year spent by family members for pasturing means suggest that there are more than one member who does this activity full time during the year. This could be possible, though, especially so if there are several heads of animals involved and because the parcela is quite far from the farmer's residence and so pasturing the animals could really be time consuming.

Table 83. Average number of hours (per year) spent by family members in each activity relating to animals only.*

Activity	Solar	Parcela	t-test
FEEDING			
Cutting of Forage			
N**	19	2	
Average	147	355	***
Pasture			
N**	-	2	
Average	-	3741	----
SANITATION			
Deparasitation			
N**	-	1	
Average	-	8	----
SALE			
N**	-	1	
Average	-	15	----

* Average refers to average numbers of hours spent by the family on the activity. Family members include the respondent.
** N refers to the number of respondents providing the information.
*** Significant difference in averages at .001 level.

All hours spent by family members were then combined and averaged for each component. Results are presented in Table 84. On the average, the family spent more hours on the animals. Family labor was 829 hours on trees, 1705 hours on the tree and crop combination, and 1369 hours on the animals, per year. This may be because of the high average reported for pasturing the animals in the parcela, as discussed above.

Table 84. Total number of hours (per year) spent by family members in tending the trees, tree/non-tree crops combined, and animals.

Total Average	Solar	Parcela	t-test
TREES			
N*	16	15	
Average	879	829	ns
TREES & NON-TREE CROPS			
N*	9	6	
Average	208	1705	ns
ANIMALS			
N*	19	6	
Average	147	1369	ns

* N refers to the number of respondents providing the information.
ns No significant difference at 0.05 level.

Hired Labor and Terms of Payment

The participation of hired farm workers in these operations were also examined. Respondents were asked about the time that hired labor was used for each component of the system. Results are presented in Tables 85 and 86.

Activities and average number of hours spent for each component are presented in Table 85. In the parcela, hired labor was used most for weeding activities for trees and then for the tree/crop combination component. Weeding is the only activity common to these components. All other activities were unique to each component. Using hired help for transportation was only mentioned for the tree/crop component, while hired help was mentioned for fertilization and for harvesting relating to trees only. Thus, hired labor in parcelas is used mostly for weeding and transportation, and very small amounts were applied to animal vaccination, tree harvesting and fertilization, and transportation for tree/crops.

Table 85. Average number of hours of hired labor (per year) for each activity for trees and non-tree crops combined, trees only, and animals.

Activity	Solar	Parcela	t-test
TREES & NON-TREE CROPS			
Weeding			
N*	1	6	
Average	75	613	**
Transport			
N*	-	1	
Average	-	450	---
TREES			
Weeding			
N*	2	5	
Average	236	1043	**
Fertilization			
N*	-	1	
Average	-	120	---
Harvesting			
N*	-	1	
Average	-	53	---
ANIMALS			
Vaccination			
N*	-	1	
Average	-	130	---

* N refers to the total number of respondents providing the information.
** Significant differences in averages at 0.01 level.

All hours of hired labor were then combined and averaged for each component and the results are presented in Table 86. From the data, the combined tree/crop component incurred the highest average total number of hours (372) of hired labor use per year. This is equivalent to about two months of one person working full time (eight hours per day, five days a week). The lowest average amount of all hired labor was for tending the trees. Based on this information, it can be deduced that the crop component (if separated from the combination) could have used more hired labor than what was spent on trees alone. Chi-square results indicate significant difference at 0.01 level between non-tree crop averages and between tree averages in terms of total hours of hired labor. As figures show, these items are higher for the parcelas.

Table 86. Total number of hours (per year) of hired labor spent in tending the trees alone, trees/non-tree crops, and animals.

Total Average	Solar	Parcela	t-test
TREES & NON-TREE CROPS			
N*	1	4	
Average	24	372	**
TREES			
N*	1	3	
Average	48	89	**
ANIMALS			
N*	-	1	
Average	-	130	-----

* N refers to the total number of respondents providing the information.
** Significant differences in averages at 0.01 level.

How much was paid for hired labor? Average total annual figures paid for hired labor are given in Table 87 These are reported in nominal 1995 New Mexico Pesos (N$) and converted to US dollars using an exchange ratio of N$6 for one US$. These results were based on the actual rates reported by the respondents. For the parcela, the highest average total annual payment for hired labor went to the tending of trees (N$907, or US$151). This was followed closely by the combination tree/crop component with N$768 (US$128). The big difference in expenses could only be explained with such reasons as bigger areas devoted to trees (more trees), or that the combined tree-nontree activities are mostly done by unpaid family members. The lowest expense (N$130 or US$21.70) was for help in tending the

animal component. Six farmers each provided figures for trees and non-tree components for the parcela system.

Table 87. Average annual total payment of hired labor used in management activities for the various components of the system, in nominal 1995 N$.

Total Average	Solar	Parcela	t-test
TREES & NON-TREE CROPS			
N*	1	6	
Average (N$)	75	768	**
TREES			
N*	2	6	
Average (N$)	236	907	**
ANIMALS			
N*	-	1	
Average (N$)	-	130	**

* N refers to the total number of respondents providing the information.
** Significant differences in means at 0.01 level.

Payment to hired labor could be in kind or in cash. A list of the activities where hired labor was paid in cash is shown in Table 88. For the parcela, it is easy to see that hired labor used in all types of activities was mostly paid in cash. This information was obtained by comparing the number of respondents providing the information given in Tables 87 and 88. However, no information was obtained with regards to which activities were usually paid in kind.

Table 88. Management activities undertaken in the system where hired labor is paid in cash.

Activities where hired labor	Solar		Parcela		Total	
is paid in cash	No.	%*	No.	%*	No.	%
TREES & NON-TREE CROPS						
1. Weeding	1	3	6	19	7	11
2. Harvesting	-	-	1	3	1	2
TREES						
1. Weeding	2	6	5	16	5	8
2. Fertilization	-	-	1	3	1	2
3. Pruning	-	-	1	3	1	2
4. Harvesting	-	-	2	6	2	3
ANIMALS						
1. Vaccination	-	-	1	3	1	2

* Based on total number of respondents per group, i.e. 33 for solar and 31 for parcela.

B.2. Solares or Home Gardens

Principal Activities and Schedules Associated with System's Components

The division of the management process into three major operations is the same as in the parcela system. These operations were establishment, maintenance, and production. Specific activities were identified as follows:

1. Establishment -- site selection and preparation, planting
2. Maintenance -- weeding, watering, fertilization, pest control, pruning, labor specifically for the crops
3. Production -- harvesting, processing, sale, transportation

For the farm activities relating to the animal component, the four major activities are the same as in the parcela and are as follows:

1. Acquisition of animals -- breeding
2. Feeding -- cutting of forage/hay, pasture
3. Sanitation -- deparasitation
4. Sale

Family Labor: Involvement of Members in Various Management Activities

Table 78 shows that the respondent is principally involved with most of the activities relating to the management of trees and crops combined. However, for the solar, the husband and wife either singly or as a team, are both involved in most other activities. This is true for most maintenance activities and also for site preparation (under establishment). Harvesting activities also involve the wife and children. The children also help in planting, weeding, and watering the plants. However, some activities are not implemented in the solar. For instance, harvesting is the one of the four production activities reported on. Moreover, there was not much maintenance (no pest control nor pruning) activities being reported.

Data obtained for family member involvement with management activities for the tree component only are presented in Table 79. Solar respondents reported that they were involved in most management activities in this system. The wife is also involved in some activities, such as site selection and preparation, weeding,

watering, fertilization, and pest control. There were two citations of children's participation -- in weeding and in pest control activities.

Some information regarding involvement of the family in the management of the animal component is shown in Table 80. One very important information is that the wife is principally leading in the cutting of hay or forage for the animals (mentioned 16 times) and in the sale (reported only by one respondent). The children are involved with cutting forage and in pasturing the animals.

Family Labor: Hours Devoted to Various Management Activities

Table 81 shows the average hours spent by the family on each activity per year for managing the combined tree/crop component of the solar. The table shows that family members spent the biggest amount of time on crop cultivation (average is 1222 hours/year or about seven months full time work for one person). This is very interesting, because this number suggests that (1) there could be more members involved in this activity, or (2) it is a longer-term intensive crop management activity near the area of residence, or (3) the areas involved could be extensive. The next highest average was 671 hours/year (almost four months equivalent full time) for weeding, which was about more than half of the time spent on crops. The lowest number was for fertilization, which is not surprising since it was mostly done by the respondent or the wife and perhaps did not require much for both trees and crops. No numbers were reported for planting and transportation activities.

With regards to family labor involved in managing the trees in the solar, there was very limited data with only two activities reported on. Nine people reported an average of 208 hours per year of family labor on weeding while one person reported a half-hour's time applying fertilizer on trees in the solar. The weeding time has an equivalent of about a month's full time work by one person. However, this time could be distributed for shorter time periods among family members, because some respondents mentioned doing weeding activities for very short time periods (less than an hour) during the week and the activity sometimes involved children.

For family time spent on activities relating to animals, there was only one activity for which information was given. For cutting forage for the animals, the average number of hours spent was 147 for the whole year as provided by 19 respondents. This is equivalent to less than a month's time in terms of the regular 8-hour/day,

5-day per week working schedule.

When all hours spent by family members for each component were combined and averages were taken (Table 84), the trees took up the biggest chunk of family labor with 879 hours devoted to trees per year. The family spent the least amount of time on the animals in the solar site. What these results imply is that there possibly could be a high number of economic trees in the solar that needs more attention than any other component. However, this is still puzzling, considering the fact that the family labor spent on the crop cultivation activity under the tree/crop combined information was way too high.

Hired Labor and Terms of Payment

Hired labor in solar operations was not much (Table 85). It was only used for weeding purposes in two components both of which involved trees: tree/crop combination and trees only. What is surprising is that, even with the small amounts of hired help used, there was a higher average used for tending trees alone which was three times than that for the combination component.

All hours of hired labor were then combined and averaged for each component and the information is presented in Table 86. There were no figures given for the animal component in the solar. The figures for the other two components were quite low. Comparing the two components, tending the trees required twice as much as that for the combination tree/crop component. This is interesting in the sense that the tree/crop combination now required less than what was used for the trees alone. Some plausible explanations could be that the crop cultivation portion is well covered by family members, and that the trees could have required more labor that the family cannot provide themselves due to other reasons.

In the solar, the average total annual figures paid for hired labor was highest for trees at N$236 or about US$39 (Table 87). The other figure that was provided by one respondent only was N$75 (or US$12.50) for tending the tree/crop combination component. No labor was hired to do any activity relating to animals. Possible reasons for the higher amount paid for tending just the trees in the solar are that there could be simply more trees that need tending, or that more labor was needed than the family can provide.

The list of the activities where hired labor was paid in cash is shown in Table 88. For the solar, only labor hired to help in the weeding activity was paid in cash. There was no other activity reported where hired labor was used in the solar, anyway.

B.3. Solares Vs. Parcelas

Principal Activities and Schedules Associated with the System's Components

There was no distinction made in the division of the management process for the solar and for the parcela system. The management process was divided into the same three major operations -- establishment, maintenance, production -- with the same specific activities. The four major farm activities relating to the animal component are also the same -- acquisition of animals, feeding, sanitation, and sale. If there were going to be differences, these were expected to be in the participation of people in the implementation of these specific activities.

Family Labor: Involvement of Members in Various Management Activities

One word of caution about these comparisons is that the descriptions here are some kind of glimpses of the involvement of various family members in the management of the system. It is very difficult to draw generalizations because of the limited data obtained. What may be more interesting here are some of the similarities and striking differences that might help draw clearer pictures of both systems and family involvement in management.

Comparing the solar and the parcela systems in Table 78, there were some small differences in family member participation based on data obtained with reference to management of trees and crops in combination. In both systems, the respondent was principally involved. However, in the parcela, there were activities where only the respondent does the work such as pest control, pruning, and most of the production activities (except harvesting). Moreover, in the parcela, the wife was less involved than the children in terms of the number of activities that they participated in. In the solar, the wife and children were often involved in more activities as well. In the solar, based on information from this table, only the wife did the crop cultivation. As a general observation, the wife is said to be "in-charge" of most solar decisions.

From Table 79, the data show that the respondents in both systems are the principal actors in the various management activities, as expected. One of the differences in the two systems is perhaps the information that the involvement of wives is mentioned more often most especially in weeding and pest control, and in the selection/preparation of the site. Also kids are involved in more activities, such as planting, weeding, pest control, and pruning, in the parcela; in the solar, kids were only involved with weeding and pest control activities. A common observation, however, is that both wives and children were not involved even in the harvesting activities where trees are concerned.

As far as the management of the animal component is concerned (Table 80), a major difference is that, in the solar, there is greater involvement by the wives in the feeding of the animals. In the parcela, only one respondent mentioned the wife's participation in feeding the animals. In both systems, the children are involved with the cutting of hay or forage for the animals.

Family Labor: Hours Devoted to Various Management Activities

The solar and parcela systems were compared in terms of family labor involved in managing the combined tree/crop component. T-tests were conducted to determine whether or not the differences in these averages is significant (Table 81). Results show that there were significant differences in the four out of five activities examined: watering, fertilization, crop cultivation, and harvesting. The most striking difference is average time spent on crop cultivation, where average for the solar is about 14 times higher than that for the parcela. This suggests two things: that there could be more members doing this activity, or that one or two people are responsible for this for extended periods of time. Either reason is possible because the area is near the residences and children easily can help after school, or the wife can devote her time there while the children are in school. These same reasons could work for watering, fertilization, and harvesting as well. The only activity where there was no significant difference was weeding, which indicates that about the same time has been spent by the family in either system.

With regards to family labor involved in managing only the trees, there was not much that could be done because of limited information. From the data obtained, the time spent by family members on weeding in the parcela is about eight times that spent in the solar. Yet, the t-test indicated there was no significant difference

in these two averages (level of significance was 0.33). The other activities could not be compared because the information was not complete for both systems.

Based on information on family labor spent on activities relating to animals, there was little more information from parcela respondents. However, because there was no corresponding figures for the solar, t-tests could only be conducted for the forage/hay cutting activity. Results of the t-test indicated a significant difference in family labor spent on this activity in the two systems. Looking closely, there were only two parcela respondents reporting an average more than twice the average reported by a larger number of solar respondents for this activity. This difference could be explained by several scenarios, some of which are: very short periods spent for cutting forage in the solar because the animals are there, the parcela is large while solar is small, and parcelas are simply farther away.

When the hours spent by the family on all activities were summed up and averaged by component, the general picture described by the t-tests is that the family is spending about the same average time on any one component in these two systems. In short, there is not much difference in the averages for the two systems (Table 84). For trees, for example, these figures were almost the same. The least difference was in the tree/crop combination which, at the level of significance of 0.313, is not really considered as highly significant.

Hired Labor and Terms of Payment

Comparing the amount and application of hired labor in both systems (Table 85), it is easy to see that there are more activities in the parcela where hired labor is used and at higher average hours. Relatively speaking, there were also more parcela respondents providing the information about hired labor. For the two averages that can be compared, the t-test results indicated that these averages were significantly different at the 0.01 level of significance. This means that the average number of hours of hired labor used in weeding activities were significantly different in both the solar and the parcela. The data indicate these averages are much higher for the parcela than the solar.

When hired labor for all activities was combined per component, parcela respondents reported using more labor for the tree/crop combination than for any other component. This could be

because of the size of the area or because of the number of species that needed to be tended to in the parcela, as compared to the solar. Hired labor for tending trees only was the least expense in the parcela. This situation is reversed for the solar, i.e., greater hired help used in trees only compared to labor hired for the combination component. Possible reasons could be that crop cultivation is mostly assumed by family members in the solar, and that the solar is smaller than the parcela and therefore can accommodate fewer plants of any species (trees or crops). The t-test indicated that the difference in average number of hours of all hired labor in the two systems was significant for the tree component and also for the tree/crop combination at the 0.01 level.

With regards to payment for hired labor, only two components (trees and the tree/crop combination) can be compared (Table 87). Based on t-tests conducted, results indicate significant differences in the average annual total payment made for each of these two components in the two systems. In other words, what was paid for hired labor for trees in the parcela is significantly different than the average amount paid for the same component in the solar. From the table it can be seen that the figures for the solar are much lower than those for the parcela.

Hired labor used in the activities in the parcela was paid in cash. There were several activities in the parcela that used hired labor. In contrast, there was only one activity in the solar that used hired labor, and in this particular activity, the worker was also paid in cash. Results indicate that payment in cash was commonly practiced. Also, it seems like hired labor is predominantly used in the parcelas rather than in solares. This could be related to earlier findings which also indicate that more family labor is spent in solares than in parcelas, especially in activities relating to animal care. Thus, where the family is directly involved, there is less labor hired.

C. Management and Decision-making

This section presents the information regarding the people who are responsible in running the daily business in tending the farm and who serve as the crucial links of the farms to the outside world: the farm managers and decision-makers.

C.1. Parcelas or Ranchitos

Decision Makers on Overall Agroforestry Operations

For the overall operations of the agroforestry farms, most of the decisions concerning the aspects of production, processing, and marketing were made by the respondents themselves (Table 89). Looking at the data for both groups, the trend is almost similar. Percentages for each activity seems to be nearly identical also. Out of those who provide the information, 15 persons (or 52%) said they decide when to produce and what to produce in the parcela, 14 persons (or 50%) make the decisions regarding the processing of the products, and 13 respondents (or 48%) do the marketing decisions.

Only in a few instances does the wife help in making the decisions in farm operations. It also surprising to note that the so-called "owner" takes part in decision making regarding the operation of the farm. Seven respondents (or 24%) cited that these "owners" decide for them about the production aspect, another seven (or 25%) mentioned that "owners" decide how farm products would be processed, and another seven farmers (or 26%) remarked that "owners" decide the marketing of the fruits and other products.

The other persons who were also cited as decision makers for the overall operations of the agroforestry farm are the parents and the children, either together or in separate groups.

Decision Makers Regarding Work Responsibility Distribution and Whether to Hire Farm Labor or Not

Over half (68%) of the respondents said they decide how the farm work responsibility would be distributed among family members (Table 90). Interestingly, "owners" were also cited by four respondents (18%) to be the decision-makers for the family on how work responsibility distribution should be done. The mention of "owners" as decision-makers could perhaps be explained by the situation wherein the land that the respondent is presently working on is previously "farmed" by another person who may have moved to another ejido but still claimed ownership of the previous parcel. Alternately, the original tiller may just have let the respondent farm the area but still expresses his "ownership" of the parcel.

Table 89. Decision makers on overall agroforestry farm operations.

	Production						Processing						Marketing					
Decision Maker	Solar		Parcela		Total		Solar		Parcela		Total		Solar		Parcela		Total	
	No.	%	No.	%	No.	%*	No.	%*	No.	%	No.	%	No.	%	No.	%*	No.	%*
Respondent only	13	46	15	52	28	49	14	48	14	50	28	49	13	48	13	48	26	48
- and wife	9	32	1	3	10	18	8	28	1	4	9	16	8	30	1	4	9	17
- and children			2	7	2	4			2	7	2	3			2	7	2	4
Spouse only	2	7			2	4	3	10			3	5	2	7			2	4
- and owner	1	4			1	2	1	3			1	2	1	4			1	2
Children only	1	4	2	7	3	5	1	3	2	7	3	5	1	4	2	7	3	6
Parents only	2	7	2	7	4	7	2	7	2	7	4	7	2	7	2	7	4	7
"Owner" only			7	24	7	12			7	25	7	12			7	26	7	13
TOTAL	28	100	29	100	57	101	29	99	28	100	57	100	27	100	27	99	54	101

* Percentage column may not equal to 100% because of rounding off errors.

With regards to hiring farm labor, six out of nine people who answered (67%) said they do the decision themselves. Again, the "owner" surfaced to be decision maker in this aspect. Two respondents (22%) mentioned that the "owner" influenced farm activities by making the decisions whether or not to get outside-of-the-farm workers (Table 91). However, it could not be explained why this is so.

C.2. Solares or Home Gardens

Decision Makers on Overall Agroforestry Operations

Closely similar to the parcela group, 13 out of the 28 solar respondents (or 46%) said they decide what and when to produce in their home gardens. But unlike in the first group, the wife's role as decision-maker is evident in the solar group with nine persons (or 32%) mentioning them as their co-decision makers. Table 89 shows another eight people (or 28%) citing the wife to be their partners in deciding the processing of products and another eight respondents (30%) mentioning the wife as their helpers in deciding over marketing strategies.

In some instances, the respondent's spouse does the decision alone regarding the production, processing, and marketing of the farm products. It would be worthy to note, however, that for operating/running the home gardens, the "owner" does not impose his or her own decisions on the respondent but rather does it together with the respondent's spouse. The other persons who also took part in deciding matters that concern the operations of the farm are the children and the parents of the respondents.

Decision Makers Regarding Work Responsibility Distribution and Whether to Hire Farm Labor or Not

As can be seen in Table 90, most of the decisions regarding the distribution of work responsibilities are done by the respondents (54%) or sometime together with the wife (29%). Since the solares or home gardens are the "place" of the wife, consulting the wife in deciding matters concerning the solar just seems to be common.

Since solares are small-parceled farms, hiring additional farm labor seems illogical. This is confirmed by the low frequency turn out. Only three people answered the question with only one person stating that he himself alone decides whether to hire laborers or not. Another person also mentioned that his wife helped him out in deciding whether they need hired labor or not.

C.3. Solares Vs. Parcelas

Decision Makers on Overall Agroforestry Operations

In both systems, most of the decisions that concern the overall operations of the farms are undertaken by the respondents. Two things are highly noticeable, however, in Table 89: the absence of the spouse in the parcela groups as sole decision-maker for all three major farm activities and the absence of the "owner" in the solar group as the only decision-maker for these three activities.

The participation of the children in the decision-making process in both groups, either as sole decision-makers or co-decision makers, is also noticeable. The parents' role as chief decision-makers is also evident in both systems.

Decision Makers Regarding Work Responsibility Distribution and Whether to Hire Farm Labor or Not

Deciding on how work responsibilities should be distributed is commonly shared by most of the respondents in the solar compared to the parcela respondents (Table 90). However, the wife seems to be more active as co-decision maker in the solares group as reported by eight respondents out of the 28 who mentioned. On the other hand, the "owner" seems to influence the distribution of work responsibilities by deciding the matter all by himself or herself. Hiring labor seems to be an uncommon practice among respondents in both groups as shown by the low frequency count (Table 91).

Table 90. Decision makers on how farm work responsibilities should be distributed.

Decision maker	Solar		Parcela		Total	
	No.	%*	No.	%*	No.	%
Respondent only	15	54	15	68	30	60
- and wife	8	29	-	-	8	16
- and children	-	-	1	5	1	2
Owner only	-	-	4	18	4	8
Parents only	1	4	1	5	2	4
Children only	1	4	1	5	2	4
Spouse only	2	7	-	-	2	4
- and owner	1	4	-	-	1	2
Total	28	102	22	101	50	100

* Percentage column may not equal to 100% because of rounding off errors.

Table 91. Decision makers on hiring farm labor.

Decision maker	Solar		Parcela		Total	
	No.	%*	No.	%*	No.	%
Respondent only	1	33	6	67	7	58
- and wife	1	33	-	-	1	8
Owner only	-	-	2	22	2	17
Spouse only	1	33	-	-	1	8
Parents only	-	-	1	11	1	8
Total	3	99	9	99	12	99

* Percentage column may not equal to 100% because of rounding off errors.

IX. AGROFORESTRY SYSTEM PRODUCTION PATTERNS

This section presents information on the products that are harvested or obtained from trees, crops, and animals. As there is no clear difference established between what is primary or secondary, all products are taken as primary unless otherwise noted (e.g., chicken eggs, banana leaves). Tables 92 to 94 present all information regarding this item. The average quantity harvested and average quantity sold of the products under each component are also highlighted in Tables 95 and 96. The market outlets as well as the uses of the portions not sold round off the discussion of the section. These are presented in Tables 97 through 101.

A. Products Harvested

A.1. Parcelas or Ranchitos

The products derived from trees are mostly fruits, the most common of which are oranges (65%), followed by mangoes (30%), avocado (10%) and coconuts (10%). Other tree species mentioned are guanabana, limon, sweet orange and mandarin. Of all the non-tree crop commodities, banana is the commonly produced (29%) followed by corn (16%) and different varieties of pepper (3%). The mention of assorted/mixed vegetables by three persons may infer that product diversification is clearly present in some ranchitos. Among the products harvested from non-tree crops which are considered as secondary products, the most commonly ones are banana leaves and squash seeds (3% each). All the other products from trees and non-trees as mentioned by the parcela farmers are shown on Tables 92 and 93. There is a wider array of non-tree outputs from the parcela compared to the solar.

Table 94 suggests that the distance of the ranchitos from the respondents' home could be one of the reasons why only few farmers raised livestock and other animals on these lots. Honeybee appears to be the safest commodity to be raised in the ranchito (13%) as the beehives can not easily be taken out or stolen from the ranchito. This is followed by sheep and pigs at 6% and 3%, respectively.

Table 92. Products obtained or harvested from trees.*

Product	Solar		Parcela		Total	
	No.	%**	No.	%**	No.	%
Orange	11	33	20	65	31	48
Mango	3	9	9	30	12	19
Limon	3	9	2	6	5	8
Avocado	2	6	3	10	5	8
Guanabana	3	9	2	6	5	8
Assorted fruits (mixed)	3	9	1	3	4	6
Coconut	1	3	3	10	4	6
Sweet Orange	1	3	2	6	3	5
Achiote	1	3	1	3	2	3
Ciruela	1	3	1	3	2	3
Mandarin	-	-	2	6	2	3
Jicaro	1	3	-	-	1	2
Ramon	1	3	-	-	1	2
Pimienta	1	3	-	-	1	2
Nance	-	-	1	3	1	2
Tamarind	-	-	1	3	1	2
Toronja	1	3	-	-	1	2

* Primary and secondary products combined. Based on the total number of respondents providing the information.
**Based on total number of respondents per group, i.e. 33 for solar and 31 for parcela.

Table 93. Products obtained or harvested from non-tree crops.*

Product	Solar		Parcela		Total	
	No.	%**	No.	%**	No.	%
Banana (fruits)	7	21	9	29	16	25
Corn	1	3	5	16	6	9
Pepper (all varieties)	1	3	4	13	5	8
Squash (vegetable)	1	3	2	6	3	5
Assorted/mixed vegetables	-	-	3	10	3	5
Banana (leaves)	1	3	1	3	2	3
Frijol	-	-	2	6	2	3
Jicama	-	-	2	6	2	3
Medicinal crops	1	3	-	-	1	2
Pepino	-	-	1	3	1	2
Sweet Potato	-	-	1	3	1	2
Squash (seeds)	-	-	1	3	1	2

* Primary and secondary products combined. Based on the total number of respondents providing the information.
** Based on total number of respondents per group, i.e. 33 for solar and 31 for parcela.

Table 94. Products obtained from animal/livestock component.*

Product	Solar		Parcela		Total	
	No.	%**	No.	%**	No.	%
Pig/Hog/Piglet	9	27	1	3	10	16
Chicken	8	24	-	-	8	13
Honey	-	-	4	13	4	6
Sheep	2	6	2	6	4	6
Turkey	4	12	-	-	4	6
Chicken (eggs)	2	6	-	-	2	3

* Primary and secondary products combined. Based on the total number of respondents providing the information.
**Based on total number of respondents per group, i.e. 33 for solar and 31 for parcela.

A.2. Solares or Home Gardens

With the exception of oranges (33%), there seems to be a wide array of products (fruits) harvested from trees in the solares than in the parcelas (Table 92). The products mentioned are mango, limon, and guanabana (all at 9%), avocado (6%) and several other fruits cited by one respondent each. A harvest of assorted/mixed fruits mentioned by three people (9%) may further explain the product diversification existing on the solar. For crops, the more popular commodity is banana (21%) followed by corn, pepper, squash, and medicinal plants (Table 93).

The proximity of the solares to respondents' homes partly explains why a lot of them raised animals/livestock. Table 94 shows that most common products are pigs/hogs (27%) which are sold per head or on a whole sale basis followed by chickens (24%). Turkeys and sheep come as next common products (12% and 6%, respectively) followed by chicken eggs (6%). Some of the pigs are butchered first before selling them out but respondents are requested to give their response in "head" unit, making "count" as the unit of measure for the animal products.

A.3. Solares Vs. Parcelas

For both systems, orange is the number one tree (Table 92). Fruits are also the number one product from these trees. Although there were more parcela respondents who mentioned harvesting from these trees, there were more tree species (greater variation) cited in the solar.

For non-tree crops, there were more respondents and greater species variation reported for the parcela. Bananas was number one among both groups. However, there were other popular crops reported for the parcela, such as corn, pepper, and assorted vegetable crops (Table 93). For livestock, there were more animals raised by more respondents in the solar than in the parcela. One possible explanation is that fewer parcela operators raise animals because the area is quite far from home.

B. Quantity of Products Harvested and Sold

B.1 Parcelas or Ranchitos

Most of the parcela respondents harvested products from their trees, crops, and animals. In terms of quantity, fruits topped the list with an annual average harvest of 23,251 kilograms, followed by crops with 3,611 kilograms, and the animals with 223 heads of livestock (Table 95). Out of these quantities, 7,533 kilograms of fruits were sold realizing an average value of N$6,570 and 2,014 kilograms of crops were sold netting N$317,907 (Tables 96 and 97). For the animals, more than half of the total heads of livestock (187 out of 233) were sold valued at an average of N$256,332 per head.

Table 95. Average quantity of products obtained from the system, by component.

Average Quantity Harvested	Solar	Parcela	t-test
TREES			
N*	12	19	
Average (fruits in kg.)	606	23251	**
NON-TREE CROPS			
N*	3	14	
Average (in kg.)	371	3611	ns
ANIMALS			
N*	12	5	
Average (per "head")	26	223	ns

* N refers to the total number of respondents providing the information.
** Significant difference in averages at 0.05 level.
ns No significant difference at 0.05 level.

Table 96. Average quantity of products obtained from the system and sold annually, by component.

Average Quantity Sold	Solar	Parcela	t-test
TREES			
N*	9	14	
Average (fruits in kg.)	459	7533	**
NON-TREE CROPS			
N*	3	8	
Average (in kg.)	175	2014	ns
ANIMALS			
N*	9	5	
Average (per "head")	6	187	ns

* N refers to the total number of respondents providing the information.
** Significant difference in averages at 0.05 level.
ns No significant difference at 0.05 level.

Table 97. Average annual sale obtained for the products sold.

Average Total Price (in N$)	Solar	Parcela	t-test
TREES			
N*	11	19	
Average	1563	6570	ns
NON-TREE CROPS			
N*	34	30	
Average	388367	317907	***
ANIMALS			
N*	34	30	
Average	256332	280453	ns

* N refers to the total number of respondents providing the information.
** Significant difference in averages at 0.05 level.
ns No significant difference at 0.01 level.

For most of the fruits and non-tree crop products sold, the farmers brought these directly to the local markets (16% and 13%, respectively) while the rest of the products were either sold in the local markets through a middleman or were sent to markets outside the community that are still within the region (Table 98). No market outlet for animal products were mentioned, although some parcela respondents reported selling products from their animal component.

Table 98. Market outlets for the harvests or products.

Market Outlet	Solar		Parcela		Total	
	No.	%*	No.	%*	No.	%
TREES						
Direct to local markets	1	3	5	16	6	9
Local markets but through a middleman	3	6	1	3	4	6
Markets outside the community but within the region	-	-	1	3	1	2
Markets outside the community but outside the region	1	3	-	-	1	2
NON-TREE CROPS						
Direct to local markets	-	-	4	13	4	6
Local markets but through a middleman	1	3	2	6	3	5
ANIMAL/LIVESTOCK						
Direct to local markets	4	12	-	-	4	6
Local markets but through a middleman	1	3	-	-	1	2

* Based on total number of respondents per group, i.e. 33 for solar and 31 for parcela.

B.2. Solares or Home Gardens

From Table 95, the average quantity of the products harvested from trees, non-trees, and animals seem to be very low in the solar compared to the quantities obtained in the parcelas. It could be due to the small areas that most solares have. There was an average of 606 kilograms of products, mostly fruits, compared to 23,251 kilograms in parcela. Non-tree crop products are almost one hundred percent less. As there were less products, there were also less quantities that were sold of outputs from the solares (Table 96).

It is interesting to note that when it comes to average total sale of the products sold, the annual sale from the solares are close to the total sale of the products sold in the parcela (Table 97). This could be explained by the fact that the products produced in solares are higher-priced products. Thus, even when the quantity produced is lower, when the prices are higher, revenues from solar outputs are also increased.

When it comes to marketing the products (Table 98), animal products find their way directly to local markets (12%), and the fruits were either directly sold locally (3%) or were sold in same local markets through middlemen (6%). It has also been mentioned by one

person that he sometimes bring his fruits to markets outside the community and region because the local markets are already "flooded" with fruits when seasonal fruits in the parcelas are harvested almost at the same time. Fruits must be disposed rapidly so as not to incur heavy losses.

B.3. Solares Vs. Parcelas

Quantity-wise, parcela respondents reported much higher figures for outputs from trees (more than 38 times greater), non-tree crops (almost 10 times greater), and even animals (almost 9 times more). However, chi-square tests indicated a significant difference in means (at 0.05 level) only for the tree products. This may be explained by the fact that the production area is much bigger in the parcela than the solar. The quantities were reported by farm or solar, not in per hectare basis. Productivity could have been indicated if this information was expressed in per-hectare basis.

Not all respondents sell everything they harvested. As expected, and on the average, more quantities were sold from the parcela because they produce more. Consequently, sales were higher for the parcela compared to the solar, except for the non-tree crops. This may be because some of the crops raised in the solar were sold for much higher prices.

In terms of percentage, parcela respondents sold more of the non-tree harvests (56% as compared to solar's 47%), and animal output (84% for parcela, 23% for solar). However, for tree outputs or fruits, solar respondents actually sold more (76% for solar, 32% for parcela) than parcela respondents, on the average. In terms of their markets (Table 98), tree products go to local markets either directly or indirectly (through middlemen). Products from non-tree crops were sold the same way by parcela respondents while middlemen were used by solar respondents. Markets outside of the ejido or community were also mentioned by one solar and one parcela respondent.

C. Uses of the Products Not Sold

C.1. Parcelas or Ranchitos

When asked how they used the portions of the products that were not sold, only a few answered that fruits were either eaten/for

home consumption (13%) or were used as feeds (13%) for the pigs, sheep, and other animals at home (Tables 99). No other uses for unsold portions of the crop and animal products were mentioned which could mean that all of these products were either sold for cash or income or given to relatives or friends.

When further queried as to how long do they expect their fruit trees to produce more, over half of the respondents cited that they hope their trees would continue to bear fruits within the next 10 years (Table 100). When their response is tested against the solares, the t-test value came out not to be significant. With regards to harvesting their wood trees (or "maderables"), many said that they could wait for at least half of a century (53 years) before they would cut down their "maderables" (Tables 101). This points out that the respondents are, indeed, highly aware of the benefits and advantages of growing and having trees on their farms and other areas.

Table 99. Uses of the products that were not sold.

Use	Solar		Parcela		Total	
	No.	%*	No.	%*	No.	%
TREES						
Eaten or Home consumption	8	24	4	13	12	19
Eaten and some were given away as gifts	2	6	-	-	2	3
Were given away as gifts	1	3	-	-	1	2
Used for animal feeds	1	3	-	-	1	2
Eaten and some were used for animal feeds	-	-	1	3	1	2
Other uses**	1	3	-	-	1	2
NON-TREE CROPS						
Eaten or home consumption	3	9	-	-	3	5
Used for animal feeds	1	3	-	-	1	2
Eaten or for home consumption and some were given away as gifts	1	3	-	-	1	2
ANIMALS						
Eaten and/or for home consumption	5	15	-	-	5	8
Other uses*	1	3	-	-	1	2

* Based on the total number of respondents per group, i.e. 33 for solar and 31 for parcela.
**Other uses refers to the combination of more than two uses such as for home consumption, given as gift, and were used as animal feeds.

Table 100. Expected average number of years of production from trees.

Average	Solar	Parcela	t-test
N*	15	18	
Average	10.1	10.1	ns

* N refers to the number of respondents providing the information.
**No significant difference in means at 0.05 level.

Table 101. Expected average number of years before respondents cut their timber trees.

Average	Solar	Parcela	t-test
N*	18	15	
Average	62.2	53.1	ns

* N refers to the number of respondents providing the information.
ns No significant difference in means at 0.05 level.

C.2. Solares or Home Gardens

Compared to the parcela respondents, solar farmers forwarded multiple uses for products that were not sold in the markets (Table 99). The most common of these uses is that the product is used for home consumption/eaten (24% for fruits, 9% for crops, and 15% for animal products, respectively). The rest of the unsold products were either given away as gifts, used as animal feeds, and used in a variety of ways. It can be inferred from the table that most of the products from the solares are used mostly for home consumption or were given as gifts or were used as feeds for animals while the products from the parcelas are commonly sold in the markets for income, especially the non-tree crop and animal products.

As with the parcela farmers, the solar group responded that they also expect their fruit trees to continue bear fruits within the next 10 years (Table 100). But their waiting period before cutting down their wood trees is 9 years longer (i.e. 62 years) than the waiting period expressed by the parcela respondents (Table 101). No other further explanation was forwarded why this is so.

C.3. Solares Vs. Parcelas

Very few parcela respondents indicated consuming the products that were not sold in the market. In contrast, more solar respondents mentioned home consumption as an important use. In addition, solar respondents provided several other uses of the unsold portion of their harvests. One inference from these responses is that solar outputs are more often for home consumption while parcela outputs are commonly sold in the market for cash income.

Expectations regarding the length or period of tree productivity (in terms of fruits) did not vary between solar and parcela respondents (Table 100). Similarly, expectations on the wood or timber output did not vary as well. The t-test results indicated no significant differences in means at the 0.05 level. These expected time periods were 10 years for fruit-bearing trees and over 50 years (53 years for parcela, 62 for solar) for the timber trees. Both sets of responses indicated the respondents' awareness of the benefits and production cycles of the various types of trees on their system.

X. PROBLEMS AND FUTURE PLANS

Presented in this section are information regarding problems that respondents have met in practicing their systems. The question was open-ended and the farmer was encouraged to mention any problem, constraint, or difficulty that was encountered as long as it was related to his/her practices or to the system being practiced. Farmers were also asked about future plans for their solar or parcela. Also presented are information about the farmer's perceptions or views of the changes in the new land tenure laws and how these changes could affect plans relating to their agroforestry systems.

A. Problems Foreseen by Ejidatarios

A.1. Parcelas or Ranchitos

Respondents were queried as to problems or difficulties that they have met in managing their trees. A follow up question was asked regarding how the farmer responded to the problem. Similar questions was asked again referring to livestock and non-tree crops. Responses are given on Table 102. Only the problems will be presented here because there was very little data recorded on how the farmers met these problems.

Table 102. Problems and/or difficulties encountered by respondents with their trees and livestock/non-tree crops.

Problems	Solar		Parcela		Total	
	No.*	%**	No.*	%**	No.	%
TREES						
Plant or animal pests and diseases	13	39	22	71	35	55
Drought, lack of irrigation system or water resources	3	9	12	39	15	23
Low prices	2	6	13	42	15	23
Lack of market facilities	4	12	7	23	11	17
Low production	4	12	4	13	8	13
Lack of technical assistance	-	-	3	10	3	5
LIVESTOCK AND/OR NON-TREE CROPS						
Plant or animal pests and/ or diseases	2	6	5	16	7	11
Drought, lack of irrigation system or water resources	-	-	5	16	5	8
Low production	2	6	1	3	3	5
Lack of market facilities	-	-	2	6	2	3
Lack of technical assistance	-	-	1	3	1	2
Low prices	-	-	1	3	1	2

* Refers to actual number of respondents who mentioned a particular problem.
** Based on total number of respondents per group, i.e. 33 for solar and 31 for parcela.

Most parcela respondents mentioned one or two items relating to the trees (Table 102), but usually only one for problems relating to livestock and non-crops. Six problems relating to trees were mentioned, the most frequently cited problem of which is plant pests and diseases (mentioned by 22 out of 31 respondents). The second and third most common problems were the low prices and drought or lack of water. There were also problems relating to market facilities, low productivity, and technical assistance. It is interesting to note that the distribution of the six problems according to some categories was not lopsided: there were two economic problems (prices and markets), two site-related (productivity and water resource), one technical, and one biological problem. The three most common ones have different categories as well.

For the livestock and non-tree components, there also were six problems mentioned. The most frequently mentioned difficulties relate to pest/diseases and drought or lack of irrigation system. The other four problems were exactly the same as those mentioned for

the trees, namely, market facilities, low productivity, low prices, and lack of technical assistance.

Generally, the problems encountered and mentioned by parcela respondents were the same for all components. The only difference was in the number of respondents who provided these answers -- there were more who have identified these problems for the tree component. However, the most frequently cited problem (pests and diseases) was the same for all components.

A.2. Solares or Home Gardens

Five problems were mentioned by solar respondents with regards to trees (Table 102). Plant pests and diseases was the number one problem; it was mentioned three times more often than the next one, implying that this must be the most common problem. Four respondents each mentioned the lack of market facilities and low production, while only three and two people cited drought and low prices, respectively, as problems.

Only two problems were mentioned relating to animals and non-tree crops. These were pests and diseases and low production, with two respondents each. Having only a couple of problems with a very low response for these two components suggest that perhaps there are less problems encountered with raising the animals and non-tree crops as compared to tending the tree component in the solar. No mention was made of the need for technical assistance nor low prices and lack of markets and even drought. A possible reason for this situation could be that there is a water system in the solar, much of the produce from the solar is mostly for family consumption or use, and so they do not worry much about low prices or lack of market facilities at all.

A.3. Solares Vs. Parcelas

Comparing the two systems in terms of the problems met relating to tending the trees, the problems were the same for both the parcela and solar with one exception -- lack of technical assistance was not mentioned by solar respondent. The number one problem (pests/diseases) is also the same for both systems and was mentioned by more respondents compared to other problems. The only other difference between both systems is that there were more parcela respondents reporting on problems compared to solar respondents.

When problems relating to the animal and non-tree components were compared, the same six problems were mentioned by parcela respondents while only two problems were mentioned by solar respondents. In addition, there were more parcela respondents reporting on these problems than that for the other system. The implication is that some solar conditions (water system and family consumption of much of the output) are such that these "problems" are not really constraining to solar respondents at all.

B. Future Plans Regarding the Systems

Respondents were asked about future plans for their system. The results, presented on Table 103, are a mixture of contrasting activities or ideas. However, looking at the more predominant plans per system will shed more light as to what could possibly happen in most parcelas or in most solares in the near future.

Table 103. Future plans for the system.

Plans	Solar		Parcela		Total	
	No.*	%**	No.*	%**	No.	%
Add/grow additional or other trees	11	33	3	10	24	38
No planned change/s; keep land as is	8	24	5	16	13	20
Add/grow additional or other crops	4	12	7	23	11	17
Remove some trees	10	30	1	3	11	17
Add livestock	3	9	3	10	6	9
Put irrigation	1	3	2	6	3	5
Increase/widen cultivated land/areas	-	-	2	6	2	3
Quit raising livestock/animals	1	3	1	3	2	3
Don't know yet	-	-	1	3	1	2

* Refers to actual number of respondents who mentioned a particular plan.

** Based on the total number of respondents per group, i.e. 33 for solar and 31 for parcela.

B.1. Parcelas or Ranchitos

Most parcela respondents are thinking of adding more trees (13 people out of 31) or adding more crops (7 people). Five others have no plan to change anything, while one or two mentioned such changes as adding/removing livestock, removing trees, installing an irrigation system and increasing the present area cultivated. All in all, nine different kinds of plans (including having no plans) were mentioned for this system (Table 103).

B.2. Solares or Home Gardens

The top three often-mentioned plans in the solar describe a conflicting message from this group of respondents. These top plans are: adding more trees (mentioned by 11 out of 33 people), removing some trees (10 people), and keep area as is (8 people). A small number mentioned adding more crops or adding livestock and an irrigation system. Knowing that there are now trees at present, and planning to add more while others may remove some (not all trees) from their solar, one can only deduce that the change would not be much and the net change would be toward more trees in the solar.

B.3. Solares Vs. Parcelas

Comparing the two systems, it would seem like there are more people thinking of bringing additional items (trees and crops and livestock) into the parcela system. For the solar, there were almost the same number who suggested opposite plans (growing versus removing trees). In both systems, there were people who did not want to change anything, at present, and just want to keep the system as it is. At least three respondents (2 in parcela and 1 in solar) are thinking of an irrigation system. This may be expected in the sense that there were more parcela than solar respondents who indicated that the lack of water resource was a problem. In addition, there are more faucets or water systems available in the solar due to proximity to residence of respondents.

C. Views/Perceptions About Changes in Land Tenure Laws

The farmers provided a very interesting, mixed set of answers to the question regarding the new changes in land tenure laws. To preserve the richness of the information, the responses were collapsed as little as possible. These results are presented on Tables 104 and 105, and are discussed by systems and then compared.

Table 104. Views or perceptions of the ejidatarios in the community regarding the new changes in land tenure laws.

View	Solar		Parcela		Total	
	No.*	%**	No.*	%**	No.	%
Don't know and/or don't understand these laws	9	27	12	39	21	33
Don't like these changes	4	12	4	13	8	13
Knows a little about these things	2	6	3	10	5	8
There are problems because there is no land distribution; some have while some don't have	1	3	3	10	4	6
Didn't do anything but wait for government to do its job	3	9	1	3	4	6
Not interested	2	6	2	6	4	6
Some think it's good; some think it's bad	1	3	2	6	3	5
Good	1	3	-	-	1	2
Dislike government because it favors investors only	1	3	-	-	1	2

* Refers to actual number of respondents who expressed a particular view.
** Based on the total number of respondents per group, i.e. 33 for solar and 31 for parcela.

Table 105. Perceptions on how the new changes in land tenure laws affect respondents' plans for their system.

Effect/s on plans	Solar		Parcela		Total	
	No.*	%**	No.*	%**	No.	%
Not affected	12	36	8	26	20	31
Don't know	5	15	1	3	6	9
Affect us (because our parcel is small)	-	-	3	10	3	5
Changes are beneficial & gives security	1	3	1	3	2	3

* Refers to actual number of respondents who mentioned particular effects on plans.
** Based on the total number of respondents per group, i.e. 33 for solar and 31 for parcela.

C.1. Parcelas or Ranchitos

From Table 104, it seems that over a third (39%) of the parcela respondents do not really understand what these changes are all about. Seven people (23%) either do not like these changes or think that there are problems associated with these changes. A few others know a little or are not interested. Based on this set of responses, one can only surmise that these changes are still unclear or unknown to most farmers or perhaps it is too soon in time to be understood by most farmers, in the area in order for these farmers to say with conviction that the changes are for the better or for the worse. This becomes clearer as farmers were asked to describe how these changes could possibly affect their plans for their parcela.

From Table 105, only 13 responses were provided in terms of farmers' perceptions of how their plans are going to be affected by changes in land tenure laws. Over a quarter (26%) of the respondents mentioned that these have no effect on their plans while 10% said that the changes will affect them because of the small size of their lots. One respondent said he/she does not know while another mentioned that the effect is positive by providing security to the farmer.

C.2. Solares or Home Gardens

Twenty-four responses were given as to farmers' views or perception of the new changes in land tenure laws (Table 104). The data indicate that over a quarter (27%) of solar respondents do not know or understand these changes. Seven people (21%) are in the group of those who know a little only, who wait for the government to do things, or who are not interested. Five persons (15%) either do not like these changes or think that there are problems associated. In sum, the mixed responses do not bode well with respect to a clear understanding of these changes and more appreciation of the same by the farmers.

Results presented in Table 105 show, however, that 36% of the solar respondents believed that these changes will not affect their plans for their systems while 15% did not know. One person, however, thought that the changes would be to his/her benefit in terms of security.

C.3. Solares Vs. Parcelas

Comparing the solar and parcela farmers with regard to their perceptions of these changes, the data show that there was a mixed set of views regarding the matter. However, the largest portion in each group (27% for solar and 39% for parcela) did not know or understand these laws. A much smaller number did not like these changes or know just a little about these changes.

A fair number of these people (36% for solar, 26% for parcela) thought that these changes will not affect their plans for their systems. The others either simply did not know or did not think about it as beneficial. A small number of parcela respondents (10%) thought these changes will affect their farming because their parcel areas were small.

In summary, the land tenure changes seemed to be unclear to most respondents in both groups. A lot of them also believe that these changes will not affect whatever their plans are for their systems.

SUMMARY

The two groups have different charateristics with respect to gender. While parcela respondents are predominantly male, the solar group is characterized by an almost equal number of female and male respondents. This difference could partly be explained by the finding that most activities in the parcela are male-dominated. With regards to age, both groups are also different; with solar respondents generally younger (average age is 41) than parcela respondents (average age is 55).

More than half of all respondents are not natives to the ejido they presently are residing in. They came from 15 regions but more than one-third of them originated from the Yucatan. The majority came during the 1971-1985 period hoping to improve their socio-economic welfare. It was a consensus, however, that their move was not at all a government-supported program. The reasons mentioned for moving in include the opportunities offered/provided in the present place, land access, because of relatives or family, and because their residence or work is here. Most of the respondents also reported to have some kind of farming background at an early age.

Education-wise, most of the respondents have low education attainment and the two groups do not differ much. The average education of parcela respondents is Grade 3 while for solar respondents, it is Grade 4. Both groups have also big families with an average of seven children for parcela and five for solar respondents. Five parcela and three solar respondents even mentioned of having 10 to 15 children.

Farming is the major source of family income as cited by most respondents from both groups. Farming is also the major income source mentioned by the spouses when asked the same question. There were several other income sources suggested but mentioned only by one or two individuals each. When it comes to involvement with organized groups, respondents in both groups mentioned member-ships mostly in producers' organizations. Examples of these groups are the sugarcane planters', wood producers, the procampo, honey producers, and chicle producer groups. The procampo is a government-sponsored program which provides incentives to farmers to grow corn.

When asked as to why they chose their present farm site, better soil and accessibility are the two reasons most often mentioned by both groups. While the choice of location for the parcela seemed to be governed by certain factors, solares are more or less associated with where residences are located. Topography of the sites in both systems are mostly flat or plain and rolling or undulating. The soils are mostly of the tsek'el, k'ankab, or puus lu'um types which are common in either higher places or in flat terrain at the foot of low hills.

A water system is present in both systems, but with a much higher percentage reported for solares (97%) than for the parcelas (68%). Faucets (potable) are the main sources of water for the solar while stream/brook is the major source for the parcela. These differences in percentage and water sources could be attributed to the relative location of the solares and the parcelas. On the average, parcela sites are 3 kilometers away from the respondents' homes, hence building an elaborate water system (like faucet or sprinkler) in the parcela is improbable, if not entirely impossible, considering the high costs associated with its construction. This is probably the main reason why most of water sources in the parcela are dependent on natural occurrences or flows.

The establishment and development of the two systems also have some similarities and differences. For instance, most parcela respondents developed their farm sites either because it is their work or employment, or because the land was given to them as gift from relatives. The solar respondents, on the other hand, also mentioned these aspects in addition to the major reasons that their residences are located here and that it is for subsistence purposes. Most respondents were exposed to farming and other agricultural activities at an early age and the majority cited personal experience or family tradition as their source of ideas for developing their system. It could be inferred then that both systems are characteristically traditional systems.

Most of the parcela and solar sites were originally either an "acahual" or were forests before farming was started out. An "acahual" is a degraded pasture that is left to fallow or a land with secondary vegetation. This information implies removal of some vegetation to give way to some crops, including the introduction of desired tree and non-tree species, in the new system.

Upon establishment, the tree species reported as planted in both systems are almost the same, with the parcela respondents mentioning more species. The most common tree species in both systems include sweet orange, coconuts, avocado, limon, mango, and mamey. The non-tree crops planted at time of establishment are also almost identical. However, for the animal component, more solar respondents mentioned bringing in more units of animals than the parcela group. This is understandable considering that most of parcela sites are located farther from respondents' homes, and some respondents have indicated problems relating to the security of their animals.

Sources of planting and animal stocks were not very different for both groups of respondents. The parcela respondents have varied sources, but the two major ones were either family-owned or were purchased stocks. In addition to these sources, solar respondents also secured some of their planting stock and animals from other ejidatarios. As to the knowledge about these farm components, both groups cited family (or indigenous) experience as their major source of idea. This further explains the traditional characteristics of the two agroforestry systems.

The farming systems also changed over time. Respondents from both groups reported changes were undertaken in the systems' three main components but many of these can best be described as crop and animal diversification. Some people reported they made many changes during the last five years (1991 to 1995) while others reported to undertake the changes all the time since they started farming. Reasons for these changes vary between and among systems. Recognition of better production opportunities was also mentioned in relation to changes in crops and trees. However, both groups are looking forward to developing what they have for their children and their future.

When asked regarding the information source about these changes, most respondents in both groups cited personal experience or knowledge. With respect to using additional inputs to implement the changes in their systems, there were more respondents who answered in the affirmative for both groups. Moreover, there were more additional resources used to effect changes in the tree component compared to the other two components.

The areas presently under cultivation vary in the two systems. While the solar is generally small with an average area of 0.36 ha., a parcela site is bigger with 5.56 has. on the average. The largest solar reported is 5 hectares, which is an exception, while that for the parcela is about 40 hectares. For the species found in the systems at present, about the same total number of tree and non-tree crop species are reported for both systems, although there were more timber/forest tree species reported in the parcela than in the solar. A greater variation in animal species was reported by parcela respondents. However, these fewer animal species were mentioned by a larger number of solar respondents, and the averages were also generally higher for the solar. The most important species cited by the two groups is orange for trees and banana for non-tree crops. However, for important animal species, more solar respondents cited chicken and hogs/pigs.

Although the systems are characterized as traditional in terms of developing the areas and the changes made, respondents from the two groups used "modern" material inputs to maintain the systems' three components. Most of these are in the form of fertilizers, weedicides, pesticides for trees and non-tree crops; and vaccines and deparasitation drugs for the animals. The costs incurred for these inputs vary in each system: more is spent in parcela for maintaining the first two components while more is spent in the solares for animal care. And all the cost and revenue figures reported in this study are in terms of nominal 1995 new Mexican peso (N$) at an exchange ratio of about N$6 to one US dollars as of July 1995.

The labor requirement for both systems is mostly satisfied by the family members, including the respondent. However, because of the limited data obtained, as provided by the well-spread but low frequency responses, drawing generalizations is a little bit difficult. One interesting finding, though, is regard to animal feeding. The survey showed that this activity is mostly done by the wife and is reported only by solar respondents (16) and none from the parcela. Weeding in tree/non-tree crop component is the activity that family members spent most of their working hours (770 hours per year for parcela, 672 hours per year for solar). However, solar respondents reported much longer working hours maintaining their cultivars (1,222 hours per year) compared to 89 hours annually in parcela sites. For tending the trees alone, more working hours are spent in parcela while the same trend is reported for both systems when it comes to animal care.

Looking at the total number of hours spent for each component, more hours are reported by parcela respondents especially in tending their trees and non-tree crops combined and in caring for their livestock. However, an almost equal total number of hours is reported in both systems when it comes to maintaining the trees.

Hired labor is also used with more hired labor reported by parcela respondents especially in maintaining the combined tree and non-tree crops and in tending the trees alone. Hired labor is always paid in cash. Total payment for services rendered for combined trees and non-tree crops amounted to N$768, while the total amount paid for tending the trees was N$907. There are no explanations as to why combined tree-nontree crop expenses are much lower than expenses for trees alone, except that perhaps larger trees are involved in the latter or that perhaps the combined tree-nontree management activities were mostly done by family members who are not paid.

In managing or running the daily business in the farm, decisions have to be made. In both systems, most of the decisions that concern the overall operations of the farms are undertaken by the farmer-respondent himself/herself. In few instances, the wife also helps the respondent (if respondent is male) in making the decisions about the production, processing, and marketing aspects of the system. The same trend is also observed when it comes to deciding how farm work responsibilities should be distributed (54% for solar respondent reporting as sole decision maker and 68% for the parcela group).

The production patterns of the two systems are observed to be similar in both groups. The primary product obtained from the tree component is fruits. However, parcela respondents reported more variation in fruit tree species than those in solar. For the non-tree crop component, banana is the most common product reported in both system. But again, there is more species variation reported in the parcela. For the animal component, more solar respondents reported to have varied products from animals. The output obtained from the animal component are from sales on a per head basis or sale on a kilogram basis. Most of these products are sold directly in the local markets.

Greater quantities of outputs are reported from the parcelas, and this difference is significant in the tree outputs (fruits, expressed

in kilograms). The same trend is observed in terms of quantities sold annually, as well as in the annual revenues received. On the revenue side, however, significant differences in average N$ figures is indicated for the non-tree crop sales only.

Problems, constraints, or difficulties do exist in both systems. Problems reported about trees include: plant or animal pests/ diseases, water-related problems, low prices of products, and lack of market facilities. The last three problems, however, are more prevalent among the parcela rather than the solar respondents. For the non-tree crops and animals, the problems mentioned are plant or animal pests/diseases and water-related constraints. These problems are also prevalent in the parcelas. Some of the pests reported are ants, mosquitoes, and birds.

The respondents also have a mixture of contrasting activities or ideas when asked of their plans for their systems. Within the parcela group, most respondents mentioned adding/growing more trees on the area, cultivating more non-tree crops, and raising some animals, while others would like to keep the farms as they are now. On the other hand, some solar respondents plan to remove some trees while others would like to add/grow more trees. Only few in both groups have indicated they have no plans at all.

When queried about their views regarding the changes in land tenure laws, the answers forwarded indicate that most of them do not know what these changes are nor do they understand these changes. However, a certain kind of optimism exists in that many respondents believe that, whatever these land tenure law changes would be, these will not affect their future plans for their farms.

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APPENDIX 1 -- INTERVIEW SCHEDULE

U.S./Mexico Agro Forestry Development Project: Characterization of Agroforestry Systems and Impact Assessment of Selected Projects

INTERVIEW SCHEDULE FOR AGROFORESTRY SYSTEMS

Respondent: _____ **Interviewer:** _____

Region: _____ **Ejido:** _____

PARCELADO/NO-PARCELADO

Date: _____/_____/_____ **Time Started:** ____ ____: ____ ____

Mo. Day Year **Time Ended:** ____ ____: ____ ____

I. BACKGROUND INFORMATION

1. Are you a native of this locality?
   1= YES **GO TO # 7**
   2= NO

2. If no, where are you originally from?
   _____ **[SPECIFY REGION AND EJIDO]**

3. When did you move to this ejido? _____ YEAR

4. Why did you move to this place?
   1= perceived additional opportunities for family members in present locality
   2= access to land problems in previous farming locale
   3= other reasons, SPECIFY. _____

5. Was your move a government-supported program?
   1= YES
   2= NO

6. Before moving to this ejido, were you involved in agriculture?
   1= YES
   2= NO **[GO TO #10]**

7. How old were you when you started helping in another person's farm? ____ AGE

8. How old were you when you started farming on your own? _____ AGE

9. **(SOLAR RESPONDENTS)** Before you started this solar, did you work in another solar or ranchito?

1= YES

2= NO **[GO TO NEXT SECTION]**

(RANCHITO RESPONDENTS) Before you started this ranchito, did you have your own solar?

1= YES

2= NO

(RANCHITO RESPONDENTS) Did you work in another person's solar or ranchito?

1= YES

2= NO **[GO TO NEXT SECTION]**

10. If YES on QUESTION #9: Are there differences between what you are doing now and what you did before?

1= YES

2= NO

If YES on QUESTION #10: Please explain the differences between your present *solar/ ranchito* and where you worked before?

_____

_____

_____

II. AF SYSTEM CHARACTERISTICS

A. Bio-physical characteristics

[= RANCHITO RESPONDENTS ONLY]**

**1. Why did you select this site for your *ranchito*?_____

_____

_____

_____

2. What are the topographical characteristics of this *solar / ranchito*? **[INCLUDE INTERVIEWER'S OBSERVATIONS]**

1= *con pendiente*
2= flat/plain
3= rolling/undulating
4= *quebrado*
5= *cima*
6= *achipotado*
7= combination/flat with undulations
8= other, SPECIFY. _____

_____

3. What types of soil are there in your *solar / ranchito*? **[REFER TO GUIDE AND INCLUDE INTERVIEWER'S OBSERVATIONS]**

_____

_____

4. Is there a water system in your *solar/ranchito*?

   1= YES

   2= NO **[GO TO #6]**

5. If YES, what is the source of water in your *solar/ranchito*?

   1= deep well
   2= well with pump
   3= water tank
   4= cistern *(tank made of cement)*
   5= stream or brook
   6= other, SPECIFY. _____

**6. How far is the *ranchito* from your home? _____ KMS.

**7. How far is the nearest _____ to your ranchito?

   main road _____ KMS.
   dirt road _____ KMS.
   path _____ KMS.

**8. How do you go to your ranchito and how much time does it take you to get there?

   1= by foot/walking: _____ HOURS
   2= by horse: _____ HOURS
   3= by bicycle: _____ HOURS
   4= by car: _____ HOURS

B. Growth and Development of the System

ESTABLISHMENT PHASE

1. What are your reasons for developing a *solar / ranchito*?

_____

_____

_____

2. When did you establish this *solar / ranchito?*_____ YEAR

3. Where did the idea of a *ranchito* come from?

   1= own experience
   2= other ejidatarios
   3= an agroforestry project, SPECIFY. _____
   4= other, SPECIFY. _____

4. Did you have a long-term plan for what plants and animals you wanted in this *solar / ranchito*?

   1= YES

   2= NO

5. What was existing in this parcel of land when you started out?

   1= milpa 4= acahual

   2= forest 5= vegetables

   3= pasture 6= other, SPECIFY. _____

6. After having cleared and prepared the land for cultivation, what plants and/or trees and livestock did you put into it?

   [REFER TO SPECIES GUIDE AND INDICATE ANSWERS ON ESTABLISHMENT PHASE TABLE .]

7. Why did you use these species?

   1= food source of the family

   2= source of feed for animals

   3= additional income source

   4= complement other crops

   5= to improve the soil

   6= for shade purposes

   7= other, SPECIFY. _____

8. Where did your plants or animals come from?

   1= another plot/milpa

   2= other ejidatarios

   3= agroforestry project technician

   4= other, SPECIFY. _____

9. When or which time of the year did you plant/bring in the animal species?

   1= rainy season

   2= dry season

   3= month, SPECIFY. _____

10. **[IF TREES ARE ALIGNED]** What is the spacing between the tree species? ___ **M.**

11. From whom did you learn all these knowledge about trees, crops, and animals?

1= family knowledge about the uses of land

2= government (e.g., SARH)

3= local organization (Consejo in Calakmul; Organizacion/OEPFZM in Zona Maya)

4= NGOs (e.g., OXFAM, PRONATURA)

5= fellow farmers/agriculturists

6= other, SPECIFY. _____

INTERMEDIATE PHASE

12. After the first half years of your *ranchito*, did you change anything?

1= YES

2= NO **[GO TO #14]**

[FOR QUESTIONS 13-20, NOTE RESPONSES ON 'CHANGES' TABLES]

13. What were these changes?

1= crop diversification

2= application of fertilizers/pesticides

3= installation of water system for crops and livestock

4= processing of primary products

5= sale of products to local and other market outlets

6= other, SPECIFY. _____

14. When did you make these changes? _____ YEAR

15. [IF NOT GIVEN BY RESPONDENT IN #13, ASK:] Did you increase (decrease) the size of your ranchito?

1= YES

2= NO **[GO TO #17]**

16. If YES, how much increase (decrease) was there? _____ HAS.

17. Why did you make these changes? _____

_____

_____

18. From whom did you get the idea for this change?

1= personal experience

2= NGOs

3= fellow farmers

4= *ejido* leaders

5= others, SPECIFY._____

19. Did you use additional resources to effect (specific change) ?

1= YES

2= NO **[GO TO #21]**

20. If YES, what was the source of these additional resources?

1= self

2= relatives/family

3= government

4= NGOs

5= local organization

6= other, SPECIFY. _____

CURRENT PHASE

21. What is the **total area** of the parcel at present? _____ HAS.

22. What are the other species that you presently have ? _____

[REFER TO GUIDE AND NOTE RESPONSES ON 'CURRENT PHASE' TABLES]

23. Out of all these trees, non-trees, and animal species that you mentioned, which would you consider to be the five most important and why?

_____

_____

_____

III. Operation and Management of the AF System [LAST 12 MONTHS ONLY]

A. Material Inputs Per Component

[USE QUESTIONS 1-6 FOR TREES, CROPS AND ANIMALS AND NOTE RESPONSES ON 'MATERIAL INPUTS' TABLES.]

1. What types of inputs did you use in your (trees/crops/animals) ?

1= fertilizer

2= pest control materials/pesticides

3= vaccines for animals

4= other, SPECIFY. _____

2. When did you use these? _____ (YEAR UNDERTAKEN)

3. On the average, how much of these inputs did you use?

_____ (USE APPROPRIATE UNIT OF MEASURE)

4. How often did you apply/use these inputs? _____ NUMBER OF TIMES

5. What was the cost per unit of the input(s) ? N$ _____

6. Where did you acquire the inputs that you used?

   1= government supplied it, SPECIFY WHO. _____

   2= NGO supplied it, SPECIFY WHO. _____

   3= bought without external assistance

   4= produced locally

   5= other, SPECIFY. _____

B. Labor Inputs per Component

[USE QUESTIONS BELOW FOR TREES, CROPS, AND ANIMALS AND NOTE RESPONSES ON 'LABOR INPUTS' TABLES.]

1. What are the principal (establishment/maintenance/production) activities for your (trees/plants/animals) ?

2. On which months are these activities undertaken? _____ MONTH

3. How many of your family members were/are involved in the establishment/maintenance/ production activities) of your *solar / ranchito*?

   0 = none

   ____ = ACTUAL NUMBER

4. Who, among them, are involved?

   1= wife

   2= sister/brother

   3= daughter

   4= son

   5= other, SPECIFY. _____

5. How much time do they devote to (activity) each day? ____ HOURS/DAY

6. How many days in each week do they put in these hours? ____ NUMBER OF DAYS

(FOR RANCHITO RESPONDENTS ONLY ON #s 7-12:)

7. Did you hire some workers to do some of the work in the *ranchito*?

   ___ = ACTUAL NUMBER

   0 = NO **GO TO C#1**

8. On the average, how many hours per day do they work? _____ HOURS PER DAY

9. For how many days each week do you hire them? _____ DAYS/WEEK

10. What was the form of payment for this hired labor?

    1= cash

    2= kind **GO TO #12**

11. IF IN CASH, what was the actual amount paid? N$_____

12. IF IN KIND, could you describe the form of payment?

    _____

    _____

C. Management and Decision-making

1. Having looked at the inputs and labor arrangements for your system, who makes the decisions in the overall operations (i.e., production, processing, and marketing activities) of the AF system?

    a. production : _____

    b. processing : _____

    c. marketing : _____

2. Who decides how the work responsibilities will be distributed?

    _____

    _____

3. Who decides on whether or not labor will be hired or exchanged?

    _____

    _____

IV. AF System Production Patterns

[USE QUESTIONS BELOW FOR TREES, CROPS, AND ANIMALS AND NOTE RESPONSES ON 'PRODUCTION' TABLES.]

1. [USING THE MOST IMPORTANT SPECIES CITED EARLIER BY RESPONDENT,] What is the primary product you harvested from them?

    _____

    _____

2. Besides that, do you use the (SPECIES) for anything else?

    1= YES

    2= NO **[GO TO #4]**

3. What are the other uses of the (SPECIES) ?

_____

_____

_____

[USE QUESTIONS 4-7 FOR BOTH PRIMARY AND SECONDARY PRODUCTS, QUANTIFY WHERE APPROPRIATE, AND USE APPROPRIATE UNIT OF MEASURE. NOTE ANSWERS ON 'PRODUCTION' TABLES]

4. How much did you harvest for each product? _____ [IN APPROPRIATE UNITS]

5. How often did you harvest (PRODUCT PER SPECIES) last year?

_____ NUMBER OF TIMES

6. IF SELLING PRODUCTS, how much was sold? _____

7. What was the price obtained for the product(s)? N$ _____

8. How much of your harvests were:

eaten (kgs) _____

given as gift (kgs.) _____

used for animal feed (kgs.) _____

used for other purposes, SPECIFY. _____

9. What were the market outlets for the sold portions or products of (trees/non trees/animals)?

1= local (directa)

2= local (with middleman)

3= markets outside the community but within the region

4= markets outside the community and outside the region

5= other, SPECIFY. _____

10. How many more years of production do you expect from your (FRUIT TREE SPECIES)?

_____ NUMBER OF YEARS

11. When do you plan to cut down your wood trees? IN _____ YEARS

V. Problems and Future Plans

1. What problems/difficulties have you encountered with your **trees**? How did you respond to these problems?

   [INDICATE PRIMARY AND SECONDARY PROBLEMS ON 'PROBLEMS' TABLE]
   [NOTE: Codes below were not in the Spanish interview schedule when interviews were conducted.]

   1= drought/lack of irrigation systems or water sources

   2= plant pests and diseases

   3= lack of market facilities

   4= lack of technical assistance

   5= lack of storage facilities

   6= low prices

   7= others, SPECIFY. _____

2. What problems/difficulties have you encountered with your **livestock and non-tree crops**? How did you respond to these problems?

   [INDICATE MAJOR AND SECONDARY PROBLEMS ON 'PROBLEMS' TABLE.]

3. What are your plans for your *solar/ranchito*?

   1= add/grow additional or other crops,

   SPECIFY._____

   2= remove some crops/cut down some trees,

   SPECIFY. _____

   3= other, SPECIFY._____

4. How do the *ejidatarios* in your community view the new changes in land tenure laws?

   _____

   _____

   _____

   _____

5. How do these new changes in land tenure laws affect your plans for your *solar/ranchito*?

   _____

   _____

   _____

   _____

VI. General characteristics of the respondent

[**ASK THESE QUESTIONS ALSO FROM WOMEN OF HOUSEHOLD]

1. Respondent's gender

   1= male

   2= female

2. Respondent's age: _____ YEARS

**3. Respondent's educational attainment: _____ YEARS

4. How many children do you have? _____ NUMBER

5. Are you a member of an organized group?

   1= Yes -- Are you an officer in the organization? What is your position?

   2= No **GO TO #6**

	ORGANIZATION	**MALE/FEMALE**	**POSITION/OFFICE**
Ejido committee	_____	_____	_____
Producers' Assoc.	_____	_____	_____
Women's Org.	_____	_____	_____
Other, SPECIFY (e.g., church):	_____	_____	_____

**6. What is the major source of your family income?

   1= farming

   2= remittances from other family members

   3= non-farming occupation, SPECIFY: _____

**7. What are the other sources of your income? (SPECIFY)

_____

_____

APPENDIX 2

EDITING GUIDELINES

General Guidelines

* Make sure all applicable questions to the two types of respondents are answered.
* All questions with OTHERS as an option should be pooled for appropriate codes.

Specific Guidelines

Top portion of the Questionnaire (for administrative purposes)

1. ENTREVISTADO. This should reflect the coding of the region, the ejido, and chronological numbering of the respondents obtained.
   The more specific codes will be:
   ZM for Zona Maya; **RH** for Rio Hondo; while the ejidos will be coded according to the first letters of their names (e.g., **X** for X-Pichil; **L** for Laguna Kana; **S** for Senor, etc.). **Parcelas** will be numbered from **001-035,** while the **solares** will be numbered from **036-070**. *(Note that this numbering allows for a total of 70 respondents. This is to enable us to obtain a little more than what is presently required of us. 60 respondents is actually the minimum required to undertake a regression analysis on the data. Statistically speaking, having more than 60 respondents offers more room for a better analysis of the data in case we have outliers or influential data points.)*
   Thus, the coding for the parcela respondents should look like as follows:
   ZM-X-001 to denote **Z**ona **M**aya, **X**-Pichil, Respondent Number **001**.
   ZM-L-006 to denote **Z**ona **M**aya, **L**aguna Kana, Respondent Number **006**.

2. ENTREVISTADOR. This should reflect the name of the interviewer in case future clarifications are needed.
3. REGION and EJIDO. This should reflect the place and the ejido where the interview was conducted.
4. PARCELADO/NO-PARCELADO. One of these two should be encircled. This is to indicate whether land rights have been granted by the ejido assembly (parcelado) or whether the ejidatario himself chose the area he is cultivating with 'authorization' from the *asemblia*.
5. DATE. This should be noted down as well so we may know when the interview was conducted.
6. TIME STARTED/TIME COMPLETED. This is necessary to know how much time we took in interviewing the respondents.

I. Antecedentes

Item #2. Make a list of the region and state and CODE accordingly.
Item #10. Make a list of differences, pool with the rest of responses, and CODE, as appropriate.

II. Caracteristicas del Sistema

A. Caracteristicas bio-fisicas

Item #1. Make a list of reasons for site selection, pool with the rest of responses, and CODE, as appropriate.

Item #4. Compute for ACTUAL NUMBER OF KILOMETERS if other units or measures of distance were given.
1 legua = 4 kilometers
1 milla = kilometers

Item #5. (See item #4)

Item #6. **Divide by 60** if answers are in minutes to convert response into hour(s).

B. Crecimiento y desarollo del sistema

Item #1. Make a list of reasons for why a solar or a parcela was established (instead of a different type of agroforestry system), pool with other responses, and CODE accordingly.

Item #10. Convert into meters if answers were given in feet.
1 meter = 3.3 feet

Item #16. CONVERT INTO HECTARES if response was in mecates.
1 hectare = 10,000 m2 = 100 * 100 m.
1 mecate = .025 hectares = 400 m2 = 20*20 m.

Item #17. Make a list of reasons for change(s), pool with the rest of the responses, and CODE accordingly.

Item #21. Convert land area to HECTARES if response was in mecates (see item #16 for conversion rates).

Item #23. Make a list of the 5 most important species, pool with the rest of the responses, and CODE accordingly.

III. Operación y manejo del sistema

A. Insumos Materiales

Item #2. Use uniform units of measure for material inputs (e.g., kilos for solid inputs and liters for liquid inputs). CONVERT, where appropriate, if answer is not in the pre-set unit of measure. For instance,
1 bulto (of fertilizer) = 50 kilos

B. Mano de Obra

Item #3. Convert into HOURS PER DAY by dividing by **60** if answers are in minutes.

Item #6. (same as item #3)

Item #10. Make a list of all possible forms of payment in kind, pool with the rest of the responses, and CODE accordingly.

C. Manejo y toma de decisiones

Item #1 (a, b, c), #2, and #3. (same as in III.B. Item #10)

IV. Producción

Item #1. Make a list of the products for each of the five important species, pool with the rest of the responses, and CODE accordingly.

Item #3. Make a list of other uses/products obtained from 5 most important species identified, pool with the rest of the responses, and CODE accordingly.

Item#4. Agree on a common unit of measure for each type of product and CODE accordingly.

Item #6. (same as IV- Item #4)

Item #7. Agree on a uniform unit of measure for quantities sold for each type of product and adjust price per unit of measure.
Item #8. Convert to KILOS if answers are in pieces or other units of measure.
Item #10. To obtain years, divide by 12 if answers are given in months.

Some useful conversion rates (fill in based on notes on the survey instrument):
1 caja (*size:* .40*.60*.25 m) = .06m3

V. Problemas y planes

Item #s 2-6. Make a list of the answers, pool with the rest of the responses, and CODE accordingly.

VI. Caracteristicas socio-economicas y demograficas del entrevistado

Item #5. Make a list of organizations and positions occupied by respondents, pool with the rest of the responses, and CODE accordingly.
Item #6 and #7: *Chicle*, as a source of income, is derived from chico zapote. This is harvested during the rainy season because secretion of the tree's resin is greater at this time. The sap or resin from the tree is often cooked in a mold until it forms into a firm gel which is then sold by kilo.

APPENDIX 3

GUIDE TO THE SOILS (SUELOS) OF QUINTANA ROO AND CAMPECHE, MEXICO

Prepared by the Agroforestry Systems Interview Team

1. Tsek´el (tambien se dice Chaltumal)
* de negro a café oscuro / from black to dark brown
* laja pedregosa/ rocky soil (including large slabs of rock)
* 10-20 cm de profundidad / 10-20 cm deep
* en partes altas / in higher places
* asociado con (associated with) Chak lu'um, Ak'alché, Puus lu 'um

2. Puus lu'um
* café a gris oscuro
  brown to dark grey
* tierra suelta con piedras (>10% pedregosidad)
  loose soil with >10% rockiness
* 40-60 cm de espesor / 40-60 cm deep
* en partes elevadas de cerros y lomas (3-10% pendiente/slope)
  on high parts of hills
* asociados con Akalche, Ya'ax hom, Tsekel, Chak lu'um (inclusiones de Ya'ax hom & Tsekel)

3. Chak lu'um
* rojo a café rojizo
* menos de 40 cm de espesor/profundidad
* en partes elevadas de cerros y lomas (1.5-10% pendiente/slope)
* asociados con (y con inclusiones de) Puus lu'um, K'ankab, Ak'alché

4. Ak'alché
* negro-grisáceo o cafe oscuro en las superficies, y gris a grís-olivo ó amarillos en los inferiores
* partes bajas de las planicies (se inunden junio - noviembre)
* 90-200 cm de profundidad (pero solo 15-60 cm efectivo)
* asociados con Puus lu'um y Tsek'el (inclusiones de Ya'ax hom y Puus lu'um)

5. Ya'ax hom
* color negro-grisáceo o café-rojizo
  black-grayish or brown-reddish
* 90-200 cm de profundidad (horizonte A: 20-50 cm)
* en partes altas de planicies
  on higher parts of flat areas
* asociados con (y inclusiones de) Puus lu'um, K'ankab, Ak'alche'

6. K'ankab
* roja bermeja / rojo / café rojizo
  bright red / red / reddish brown
* > 1m de espesor, a veces > 2m (horizonte A: 0-5 cm)
  > 1m deep, sometimes > 2m (A horizon: 0-5 cm)
* en planadas, en las estribaciones de colinas de baja altura
  flat terrain, at the foot of low hills
* associated with Chak lu'um & Ya'ax hom, inclusions of Chak lu'um & Tsek'el

APPENDIX 4

LIST OF COMMON TREES AND THEIR LOCAL AND SCIENTIFIC NAMES IN QUINTANA ROO AND CAMPECHE, MEXICO

Prepared by the Agroforestry Systems Interview Team

A. ARBOLES (TREES)

1. COMESTIBLES

No.	Nombre comun (Espanol)	Nombre comun (Maya)	Nombre scientifico (Uso)
1.	achiote	cuchum	Bixa orellana
2.	aguacate	oon	Persea americana
3.	anona		Annona spp.
4.	caimitillo/caimito		Chrysophyllum mexicanum
5.	ciruela		Spondias purpurea
6.	coco		Cocos nucifera
7.	coyol/cocoyol	tuuc	Acromia mexicana
8.	corozo		Orbignya cohune
9.	granada		Punica granatum
10.		grosella	Phyllanthus acidus
11.		guanabana	Annona spp.
12.		guaya	Talisia olivaeformis
13.		guayaba	Psidium guajaba
14.		limón	
15.		mamey	Pouteria sapota
16.		mandarina	
17.		mango	
18.		marañon	Anacadium occidentale
19.		nance/nanche	Byrsonima crassifolia
20.		naranja agria	
21.		naranja dulce/naranja china	
22.		pimienta	Pimienta dioica
23.		saramuyo	Annona squimosa.
24.		tamarindo	Tamarindus indica
25.		toronja	
26.		zapote/chico zapote*	Manilkara zapota
27.		zapote negro	Dyospiros disyna

2. MADERABLES

No.	Nombre comun (Espanol)	Nombre comun (Maya)	Nombre scientifico (Uso)
28.	álamo	koopó	Ficus cotinifolia/glaucescens
29.		balché/ ba'al ché	Lonchocarpus lonfistylus
30.	caoba	punab	Swietania macrophylla

31.	cedro		Cedrela odorata
32.		chak-teh/chacte	Caesalpinia gaumeri
33.		chechem/ceechen	Metopium brownei
34.	corcho		Pachira acuatica
35.	granadillo		Platymiscium yucatanum
36.	guayacán	soon	Guaiacun sanctum
37.	jobo	abal soot's	Spondias mobin
38.		machi-che	Lonchocarpus castilloi
39.	negrito	pasa'ak	Simarouba glauca
40.	(guanacaste)	pich	Enterolobium cyclocarpum
41.		pucte'	Bucida buceras
42.	roble		Ehretia tinifololia
43.	chacá blanco	sac-chaca'	Dendropanax arboreus
44.	siricote	kopté	Cordia dodecandra
45.		tzalam*	Lysiloma bahamensis

B. FORRAJEROS (FORAGE)

No.	Nombre comun (Espanol)	Nombre comun (Maya)	Nombre scientifico (Uso)
46.	capulín		Muntigia calabura
47.	cocoite	sak yáab	Gliricidia sepium
48.	dormilón		Pithecellobium saman
49.		chaca'	Bursera simaruba
50.	guacimo		Guazuma ulmifolia
51.		huaxin	Leucaena leucacephala
52.	ramo'n	ox	Brosimum alicastrum

C. OTROS (OTHERS)

53.	almendro		Terminalia catappa
54.	bonete	k'uum ché	Jacarita mexicana
55.	guano		Sabal japa
56.	guarumo	k'o'och lé	Cecropia peltata
57.	jabi'n		Piscidia piscipula
58.	jaboncillo		Sapindus saponaria
59.	ji'caro		Crescentia cujete
60.	kaniste	ka'nixte	Pouteria campechiana
61.	limonaria		Murraya paniculata
62.	maculis	xmaculis	Tabebuia rosea
63.	quina		Exotema mexicanum
64.		sacpa	Byrsonimia buidaefolia
65.	tronador	kan lool	Tecoma stans
66.		visinic	Alvaradoa amorphoides
67.		yaiti	Gymanthes lucida
68.		yax-nik	Vitex gaumeri
69.	zapotillo		Pouteria unilocularis

APPENDIX 5

Economics of Caoba (*Swietenia macrophylla*)
Agroforestry Models for the Yucatan Peninsula, Mexico

by
Joe Colletti and Lita Rule, Department of Forestry, Iowa State University, Ames, IA USA
and
Conrado Parraguirre Lezama, INIFAP: Instituto Nacional de Investigaciones Forestales y Agropecuarias, San Felipe Bacalar, Bacalar, Quintana Roo, Mexico

I. Introduction

Caoba (*Swietenia macrophylla*, King) is an important and very valuable tree species native to the Yucatan Peninsula of Mexico. Considerable research has been done on the biological aspects of regenerating, growing, and managing natural and plantations of Caoba (Snook, 1993; Negreros-Castillo, 1991; Lamb, 1959, 1966). Results from Instituto Nacional de Investigaciones Forestales y Agropecuarias (INIFAP) researchers and others clearly indicate the growth and yield potential of plantations of caoba on the soils of the Yucatan.

The Yucatan peninsula is characterized by a subhumid, warm climate with mean temperatures ranging from 22.4 and 27.8 C throughout the year. The precipitation is variable with lower amounts between 500-700 mm in the north (Yucatan state) and 1200-1500 mm in the south (states of Campeche and Quintana Roo) of the peninsula. The rainfall is typically partitioned into the dry period with less than 50 mm per month for four to five months and the wet period (May through November) with 100-200 mm per month.

The soils are generally good to poor and variable compared with states not in the Yucatan peninsula to the west such as Vera Cruz. Soils are thin (15 - 50 cm deep), stony, and under-layered with lime or white marl. The dominant soil types are rendzina, lithosol, and gleysol/vertisol.

The traditional and ubiquitous land use system in the Yucatan is the *milpa* (slash and burn) agricultural system. This system is very old and involves three parts - *roza*, *tumba*, and *quema* to produce maize (Zea mays) for subsistence and market purposes. This slash and burn agriculture depends on an appropriate fallow period after the

typically three years of corn, beans, and other annual crop production. The fallow period means that "natural forest succession" will occur such that after ten to fifteen years the cycle of slashing, burning, and maize production starts again (CIQRO, 1980, 1983).

Another important land use system is using the natural forests for the production of a few high quality timber species including mahogany (*Swietenia macrophylla*), cedar (*Cedrela odorata*) , and chicle (*Manilkara Zapote*).

One limiting factor slowing the spread of caoba plantation establishment and management on ejido lands in the Yucatan is the length of time that it takes for a timber crop and the lack of a positive net cash flow until 15 years after plantation establishment. Typically the first commercial thinning of caoba that yields usable timber products (pole and post material in this case) occurs at 15 years after establishment. What is needed are alternative ways to establish caoba such that the farmer's relatively scare land, labor, and capital resources are used effectively to produce useful products for family consumption and market sale.

In short, what is sought are alternative caoba systems that minimize labor and capital/material inputs, recognize the relatively poor soil resources of the region and yield annual positive cash flow as early and for as long as possible prior to the quality harvest of Caoba from the commercial thins and final sawtimber and veneer harvest. The assumption is that a farmer is likely to perceive the risk of a caoba plantation with early crops and positive cash flows to be acceptable whereas a caoba-only plantation with the first positive cash flow occurring at year 15 may have too high of risk factor for the farmer, thus reducing likelihood of adoption.

Agroforestry models which are a blend of caoba and other shorter duration crops such as maize, squash, melons, and fruit trees (Avila, 1993; Aiyelaagbe, 1992; Porras and Luyano, 1974) seem to offer the opportunity of "cash forwarding" and eventually higher valued timber yields at year 35 to 40- the end of the expected rotation. In addition to affecting the perceived risk associated with the plantation, because of the "cash forwarding effect" the economics of the agroforestry alternatives (caoba plus other crop(s)) is greatly enhanced. Moreover, with proper design, there is the potential of added extra-market benefits such as enhanced soil conservation, improved wildlife habitat, and aesthetics (Sullivan et al., 1992).

II. Objectives

There are two objectives of this economic analysis. First, to determine the potential profitability of three alternative caoba agroforestry models compared with a caoba plantation using various economic criteria. And second, to analyze the factors of production for each model in terms of their impacts on the economic criteria.

III. Methods

The Agroforestry Models

Four basic models are evaluated. Model 1 is a pure caoba plantation. Young nursery-grown seedlings (1-0) are planted in a prepared and suitable soil at a spacing of 5 x 5 m (400 trees per ha.). A specific set of activities occurs to manage the plantation with thins at years 8, 15, 25, and the final harvest of 100 crop trees (>40 cm dbh) at year 35.

Model 2 is a caoba plus maize agroforestry system. Maize production occurs only in years 1 and 2 with yields estimated at about 1 MT per ha in year one and 0.5 mt per ha in year 2. Nair (1989) classifies this system as a *taungya* agrisilvicultural system with the caoba tree crop the primary objective of the system, but with annual agricultural crops providing added income to the farmer/landowner.

Model 3 is a caoba plus fruit tree agroforestry system. The caoba is planted on a 10 x 5 m spacing (200 trees per ha) and the fruit trees are planted on a10 x 10 m spacing (100 trees per ha). Planting of the fruit trees will occur in year 1 at the same time as the planting of the caoba seedlings. There is no maize in the system. There are three subsystems each with a different pure planting of fruit trees; oranges, bananas, and papaya. This model can be classified as an agrisilvicultural plantation crop combination where fruit crops are mixed with timber crops (Nair, 1989).

Model 4 is a caoba plus maize plus fruit tree agroforestry system. Again, there is no maize in this system. The same three fruit sub-systems - oranges, bananas, papaya - are to be planted in pure stands. This model is also an agrisilvicultural plantation crop system with intercropping of maize early in the plantation life and emphasize one fruit (banana and papaya) and caoba production (Nair 1989).

These four models represent feasible systems applicable to specific soil and land types in the Yucatan. Progressing from Model 1 to

Model 4, each is more complex in terms of the expected plant interactions, management skills required to yield expected products, product output and apparent economic value per annum and total.

Two different rotation lengths are investigated; 35 and 40 years. Based on natural forest stands with Caoba and many other species of trees, it is estimated that for pure plantations of Caoba, thirty-five years is a minimum rotation length to produce sawlog-sized material (to be cut into lumber). A forty-year rotation is expected to produce about 60% of the timber yield as sawlog material (lumber) and 40% as veneer quality logs.

The economic models will be constructed with and without annual land rent. Given the 1992 land reform law which provides the farmer members of ejidos with the opportunity to own the land they work, it is important to evaluate the impact of including the opportunity cost of land in the model analyses. It is unclear how the recent land reform law will effect the adoption of agroforestry systems or modify the milpa or native forest management. Jaenicke (1994) suggests that the land tenure reform law may provide a positive impact on adoption of agroforestry systems by ejido farmers in the central region of Quintana Roo.

Model Assumptions

There are several basic assumptions common for all models. They are: 1) all costs and prices are in constant 1993 nuevo pesos (N$), 2) all inputs and yields, costs, resources, and prices are deterministic, 3) all models are evaluated using real discount rates, 4) two rotation lengths, 35 and 40 years are evaluated, and 5) all excluded factors of production are assumed to be unimportant.

IV. Economic Criteria

Three economic decision-making criteria are used to evaluate the caoba and caoba-agroforestry models in terms of their profitability. The primary criteria are net present value (NPV) and annual equivalent value (AEV). NPV is used because it is the appropriate decision criterion for the long term financial cash flows associated with caoba forestry production. It provides the time-adjusted net return (per ha in this case) from a series of negative and positive cash flows for one fixed period of investment (35 years in this case) (Canada and White, 1980). Because the farmers are accustomed to annual negative cash flows (input costs) and annual positive cash

flows (total value of crop - i.e. maize) having NPV expressed in annual net return per ha (from each forestry model) generates an understandable and familiar result. Thus, AEV is the expression of NPV on an annualized basis. The internal rate of return (IRR) is also computed for the models. This decision-making criterion represents the real return on nuevo pesos invested in each forestry model such that the sum of the discounted costs equals the sum of the discounted returns. Its appeal as a criterion is that IRR is expressed as a percentage as are the cost of borrowing money from a bank or the interest paid on savings. The IRR avoids the difficult problem associated with the determination of the correct discount rate, although the IRR must be compared with an ARR to decide the worth of a project. The IRR criterion is not the primary decision criteria because of the problems associated with non-conventional cash flows that are likely with the caoba/caoba-agroforestry models evaluated (Canada and White, 1980).

All economic are done using 1) an inflation-free (real) discount rate, 2) constant costs and prices (1994 N$- nuevo pesos), 3) deterministic outputs and activities, 4) metric yields per ha, and 5) N$ per ha.

For this study the relevant real discount rate is based on the nominal cost of borrowing capital from Banco de Mexico - FIRA which in March of 1994 was 6.9%. Assuming an annualized rate of inflation of 4% for Mexico, the corresponding real rate of interest is approximately 3% (the real discount rate will be referred to as the real ARR- alternative rate of return henceforth). The precise real ARR is determined by deflating (dividing) (1 + nominal rate) by (1+ rate of inflation). For example, 1+ Real ARR = (1.069) / (1.04) = 1.028, or the Real ARR = 0.028 (~ 3%) (Canada and White, 1980).

To achieve objective 2 of the study, a sensitivity analysis of key factors of production will be done to determine the effect on decision-making criteria and hence the comparable profitability of each model. Yields, prices, costs, federal subsidies, and the inclusion or exclusion of land rent will be investigated.

V. Results From the First Three Agroforestry Models

All economic analyses are not completed. We have analyzed the discounted cash flows for the model 1 through 3 at a fixed rotation length of 35 years. Table 1 presents the net present value (NPV), annual equivalent value (AEV) , and internal rate of return (IRR)

criteria values for models 1 through 3 at two real rates of discount (ARR = 3% and 5%).

Model 1, which is a pure plantation of caoba with a fixed rotation age of 35 years, has the potential to be "profitable" for a producer over the 35 year period. The annual net return as measured by AEV is N$ 586 at 3% and drops to N$312 at 5%. Assuming that the 5% real discount rate is an accurate time value of money and reflects the risk of the project through the "eyes" of the producer, this system is acceptable because the IRR (8.23%) exceeds the ARR (of 5%). As maize and orange trees are added to the caoba plantation, making it an agroforestry system, the economics improve. In fact, model 2 (caoba with maize) has a NPV at 3% roughly N$1,000 above that of the pure plantation. Model 3 (caoba with orange trees) also provides greater economic potential for the landowner relative to model 1. With continued opportunity for the producer to own the land from which they produce annual and perennial crops, there is a small to modest negative impact on the net returns from the systems when land rent is charged for ownership. If the federal or state government wished to subsidize these systems, the NPV, AEV, and IRR of each system improves.

Table 1. Comparison of economic criteria for three agroforestry systems in the Yucatan with caoba, maize, and fruit trees. Units expressed in New Pesos (N$) per hectare.

Model Type	Net Present Value 3%	Net Present Value 5%	Annual Equiv. Value 3%	Annual Equiv. Value 5%	Internal Rate of Return
1. Caoba	12,600	5,109	586	312	8.23%
Caoba w/ rent	12,171	4,781	566	292	7.97%
Caoba w/subsidy	13,167	5,666	613	346	8.93%
Caoba w/rent+sub	12,738	5,338	593	326	8.63%
2. Caoba & Maize					
base	13,514	6,018	629	368	9.50%
w/ rent	13,084	5,691	609	348	9.15%
w/ subsidy	14,081	6,575	655	402	10.65%
w/rent & subsidy	13,651	6,248	635	382	10.20%
3. Caoba & Orange Trees					
base	13,288	8,206	618	501	16.77%
w/ rent	12,858	7,878	598	481	16.26%
w/ subsidy	13,685	8,593	637	525	18.44%
w/rent & subsidy	13,253	8,265	617	505	17.88%

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